

**EXPLORING CENTRAL BANK COMMUNICATION AS A
POLICY TOOL:
AN ANALYSIS OF THE BANK OF ENGLAND**

Submitted in partial fulfilment of the requirements for the award of the degree
of Doctor of Philosophy at Birkbeck, University of London

By

ADETOLA ADESINA
Department of Economics, Mathematics and Statistics
JULY 2019

Abstract

We explore policy communication documents from the Bank of England as a means of understanding how communication can drive policy. This dissertation contributes to the literature in three ways. First, using textual analysis of the Bank's periodical communication, we assess if the complexity and tone of these communications are influenced by the macroeconomic conditions during which the communication is made: we focus on macroeconomic conditions that the Bank closely monitors and, in some cases is assessed by, such as inflationary pressures and international competitiveness of the pound. Secondly, using a FAVAR model, we assess if communication shocks are transmitted to key macroeconomic variables. Our intuition is that if communication is to aid monetary policy, then understanding the direction of shock transmission from communication to the macro environment becomes important. Finally, we explore volatility transmission from the Bank's communication to the stock-market, and currency and bond markets, based on the complexity and tone used in communication.

We find that inflationary pressure impacts the complexity and tone of the Bank's communication; exchange rate pressures also affect the complexity of communications. Specifically, under 'unfavourable macroeconomic conditions' (rising inflation accompanied by widening inflation gaps and falling pound values), the Bank's communication displays greater complexity, reduced optimism and increased uncertainty. Our findings on the transmission of shocks from communication to macroeconomic variables are mixed; however we find that optimism shocks impact macroeconomic variables in a similar way to a contractionary monetary policy. We also show using Factor Error Variance Decomposition (FEVD) analysis that complexity and optimism shocks contribute more to explaining some variations in financial markets in the immediate term than the policy rate does. Our results regarding the role of communication in market volatility also suggest that rising optimism reduces volatility in the stock market and currency markets but complexity has little impact on volatility. Overall, our findings have significant policy implications for the Bank of England as it seeks to understand the role of communication in policy making.

Dedication

To Kachi and Jidenna Jeremi Tila-Adesina.

Acknowledgements

I would like to express my sincere gratitude to my supervisors Professors Sandeep Kapur and Ron Smith for their continuous support, patience, motivation, and immense knowledge demonstrated during my Ph.D. study and related research.

I also thank Professor Kamil Omoteso for supporting me with the time and resources needed to complete this research.

I am thankful to Coventry University for funding received to pursue this research. My sincere thanks also go to Chris Giles of the Financial Times for giving me the opportunity to showcase aspects of my work in the Financial Times.

To Nedu, best believe. To my mum and siblings, thanks for always being here.

Finally, I would like to express my sincere gratitude and appreciation to my lovely wife 'Kachi, without whose love and support I would not have been able to conduct this research.

Table of Contents

CHAPTER ONE	7
1.0 INTRODUCTION AND BACKGROUND.....	7
1.1 Introduction	7
CHAPTER TWO	19
2.0 LITERATURE REVIEW	19
2.1 Introduction to central bank communication	19
2.2 The Bank of England.....	23
2.2 Central bank communication as a policy tool	26
2.3 The role of intermediaries in central bank communication.....	31
2.4 Central bank transparency: theoretical background.....	36
2.5 Central bank transparency and the linkage between complexity and tone.....	41
2.6 Central bank communication: empirical evidence and cross-country variation	45
2.7 Capturing central bank communication.....	48
2.8 Optimism and uncertainty in central bank communication.....	51
2.9 Conclusion.....	56
CHAPTER THREE.....	57
3.0 DATA ON CLARITY AND TONE – READABILITY STATISTICS AND THE DICTION SOFTWARE	57
3.1 Introduction	57
3.2 Quantifying the tone of central bank communication: Diction Software.....	70
3.3 Text processing approach used for textual analysis.....	82
3.4 Conclusion	84
CHAPTER FOUR.....	86
4.0 THE EFFECTS OF MACROECONOMIC CONDITIONS ON THE COMPLEXITY AND TONE OF	86
CENTRAL BANK COMMUNICATION.....	86
4.1 Introduction	86
4.2 Analysing complexity of Monetary Policy Committee (MPC) minutes and inflation reports.	88
4.3 Macroeconomic data	95
4.4 The impact of macroeconomic conditions on clarity and tone.....	96
4.5 Tests for model misspecification	99
4.6 Results	100
4.7 Conclusion.....	107
CHAPTER FIVE	110
5.0 EVALUATING SHOCK TRANSMISSION FROM CENTRAL BANK COMMUNICATION TO THE	110
MACROECONOMIC ENVIRONMENT.....	110
5.1 Introduction	110
5.2 Methodology: FAVAR framework	114
5.3 Estimation and data	120
5.4 Results	122
5.5 Conclusion	161
6.0 CENTRAL BANK COMMUNICATION AND FINANCIAL MARKET VOLATILITY	165
6.1 Introduction	165
6.2 Complexity and tone of communication and financial market volatility	167
6.3 Methodology and data	169
6.4 Results	171
6.5 Investigating the existence of reverse causation in our models.....	177
6.6 Conclusion	178

CHAPTER SEVEN	180
7.0 Summary and Conclusions	180
7.1 Implications for policy	186
7.3 Limitations	187
7.4 Future research	188
APPENDIX	190
Appendix A: Non-linear analysis of the relationship between complexity/tone and the macroeconomic environment.....	190
Appendix B: Subsample analysis of the MPC communication regimes	194
Appendix C – Macroeconomic variable inputs to the FAVAR Model.....	198
Appendix D: Impact of lagged volatility variables on communication	200
Appendix E: Summary of research questions, expected findings and thesis findings	202
References	210

CHAPTER ONE

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

Central Bank communication as a monetary policy tool has gained more prominence in recent times as the need for transparency and accountability have increased amongst inflation-targeting central banks. As inflation targeting requires that central banks relate their policy actions to their inflation forecasts, there arises a need for precise communication that justifies policy actions. Additionally, major central banks have faced a new wave of challenges brought about by near-zero interest rates (the zero-lower bound). The major difficulty faced in such an environment is how to keep monetary policy going without the option of further reducing rates beyond the zero-lower bound. Furthermore, following the global financial crises of 2007/2008, communication by policy makers has been under more scrutiny as markets look to the central banks for guidance about the future path of policy. This ‘forward guidance’ is now being provided by central banks as a central policy theme. Indeed, as more central banks move towards inflation targeting as a central policy theme, forward guidance and the communication that drives it become increasingly important.

To highlight the importance of communication in today’s monetary policy tool kit, former Fed chairman Ben Bernanke, whilst explaining the Fed’s policy on the *60 Minutes* television show, famously stated that “monetary policy is 98% talk and 2% action.” The choice of such a television show, which was the most watched news magazine in the US at the time, is also of importance as it underlines the efforts of central bankers to stress communication as central to its policy making. On another occasion, Bernanke was quoted as suggesting that “a major element of best-practice inflation targeting is the communication strategy.” These comments by one of the world’s most successful central bank policy makers affirm the role that communication has come to play in today’s policy making and also in the direction of monetary policy for the future.

As monetary policy driven by communication becomes more mainstream today and market participation widens, mainly due to technological advancements, central banks continue to use their voices via more media outlets. More recently, virtually all central banks have become active on social media and are putting out communications about their intentions and activities in real time. The implication of this is that every communication by central banks therefore becomes a calculated step, an intentional rhetoric. Given these developments, it is therefore pertinent that modern day research explores communication from central banks more

critically. Indeed, the Bank of England (BoE) through its One Bank research agenda, stressed analysing policy communication as one of the frontier research areas it seeks to pursue imminently (Bank of England, 2015).

There is substantial evidence that major central banks around the world have traditionally provided the public with relevant information regarding the implementation of monetary policy (see Eijffinger and Geraats 2006; Dincer and Eichengreen 2007). In fact, according to Fracasso et al.'s (2003) analysis of 20 inflation-targeting central banks, the Bank of England was thought to provide some of the highest quality and quantity of information to the public. However, what is unclear within the literature is the extent to which the quality of such communication varies over time and what factors may drive such changes in the quality of communication. Of course, there is no generally accepted measure of the quality of communication, but the common assumption is that transparency and accountability are highly desirable traits by inflation-targeting central banks and are arguably some of the most important factors that enhance effective inflation-targeting policy. The Bank of England in particular has worked towards greater transparency and accountability, mainly driven by the concerns of the Treasury Select Committee, which suggested that the Bank's governance 'needs strengthening and that it needs to be more open about its work' (House of Commons Treasury committee, 2011; p 3).

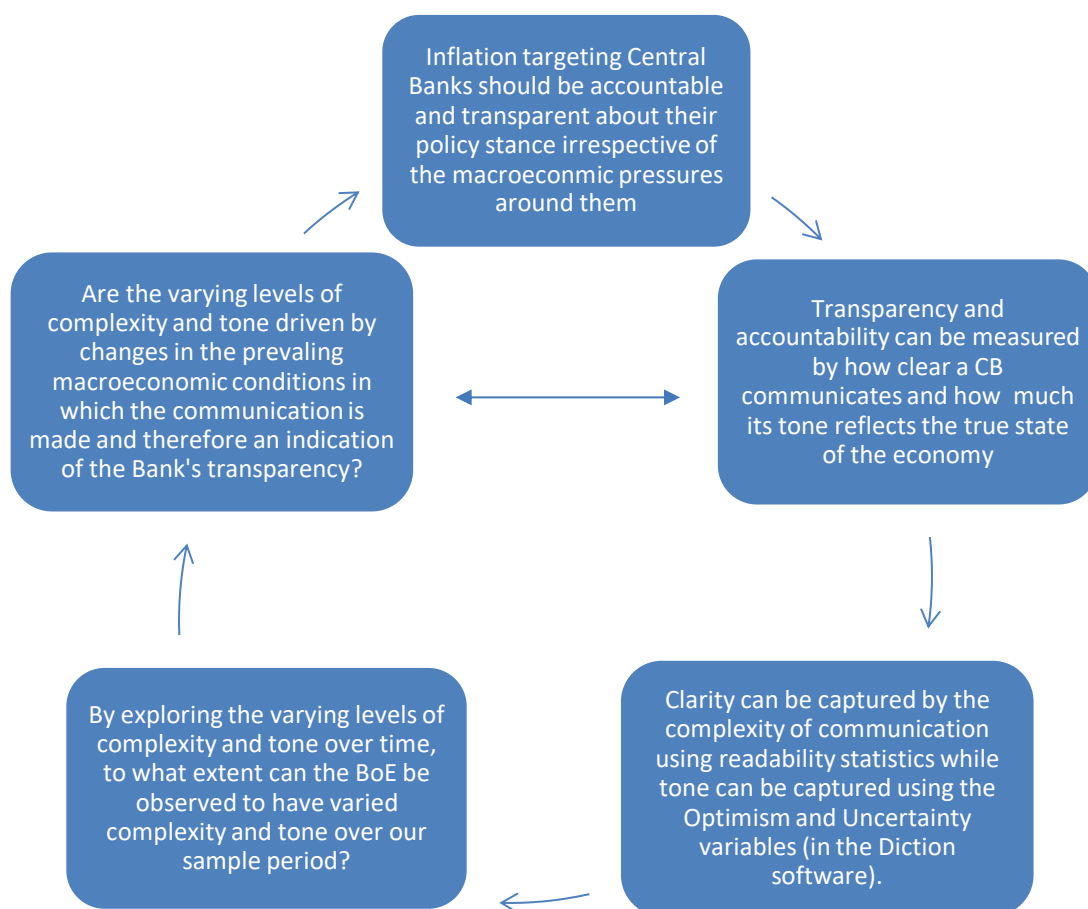
To this end, the first part of our work seeks to address *two fundamental research questions* about the time-varying characteristics of central bank communication using information from the Bank of England. We begin by carrying out textual analysis of the Bank's communications, as captured in periodic Monetary Policy Committee (MPC) meeting minutes and inflation reports, and use standard software to measure the 'complexity' and the 'tone' (optimism and uncertainty) of these communications. We then test if the trend of the complexity and tone of the Bank's communication have changed significantly over our sample period given the increased demand for transparency and accountability during this time. We expect that a more transparent and accountable central bank is one that communicates in a less complex manner, and whose tone reflects the true state of the economy at the time the message is being communicated.

Second, we explore the extent to which the variations in complexity and tone are influenced by the prevailing macroeconomic conditions during which the communication is made. We hypothesise that as an inflation-targeting central bank that is required to explain significant deviations of its policy actions from its inflation target (i.e. accountable), the bank may be '*less clear, less certain and less optimistic*' when macroeconomic environments are

unfavourable. For the purposes of this research, we define unfavourable macroeconomic conditions for an inflation-targeting central bank as one in which prevailing inflation is rising and is further away from its target, or one in which exchange rate pressures are leading to the depreciation of the local currency.

For a central bank that is seeking to be transparent and accountable, such increasing *complexity* and *uncertainty* and *reduced optimism* in the Bank's communication under unfavourable conditions may very well be as a result of the Bank's openness on its views about the economy. Our expectations for perceived transparency are for communication to be consistently more complex, uncertain and less optimistic as inflation moves further away from the inflation target and as the pound depreciates. Our findings from this section also contribute to the ongoing debate as to whether central banks should be fully transparent or whether they should limit their transparency. We call this initial section of our work the 'back end' analysis and the diagram below highlights the framework through which we explore this and why this analysis is important. Figure 1.1 below helps elaborate on how analysis of the tone and complexity of central bank communication may help understand central bank transparency better.

Fig 1.1: Back end analysis – Why is it important to understand what drives the complexity and tone of central bank communication?



To further evaluate how a central bank’s response to complexity and tone of communication might vary under different circumstances and the potential motivation for these variations, we consider four different scenarios in figure 1.2 below, where an inflation-targeting central bank may be forced to react in different ways due to the need for accountability and transparency. We can categorise scenarios as those in which the outcome is positive or negative, and we may have views on the underlying causes that led to these outcomes. For instance, the mid-air breakup of NASA Challenger space shuttle in 1986 with the deaths of all seven crewmembers was clearly a disaster, but conventional wisdom suggests that the underlying cause was relatively simple: the failure of O-rings, a key component (see Romzek and Dubnik (1987) for linkage between the disaster and public accountability).

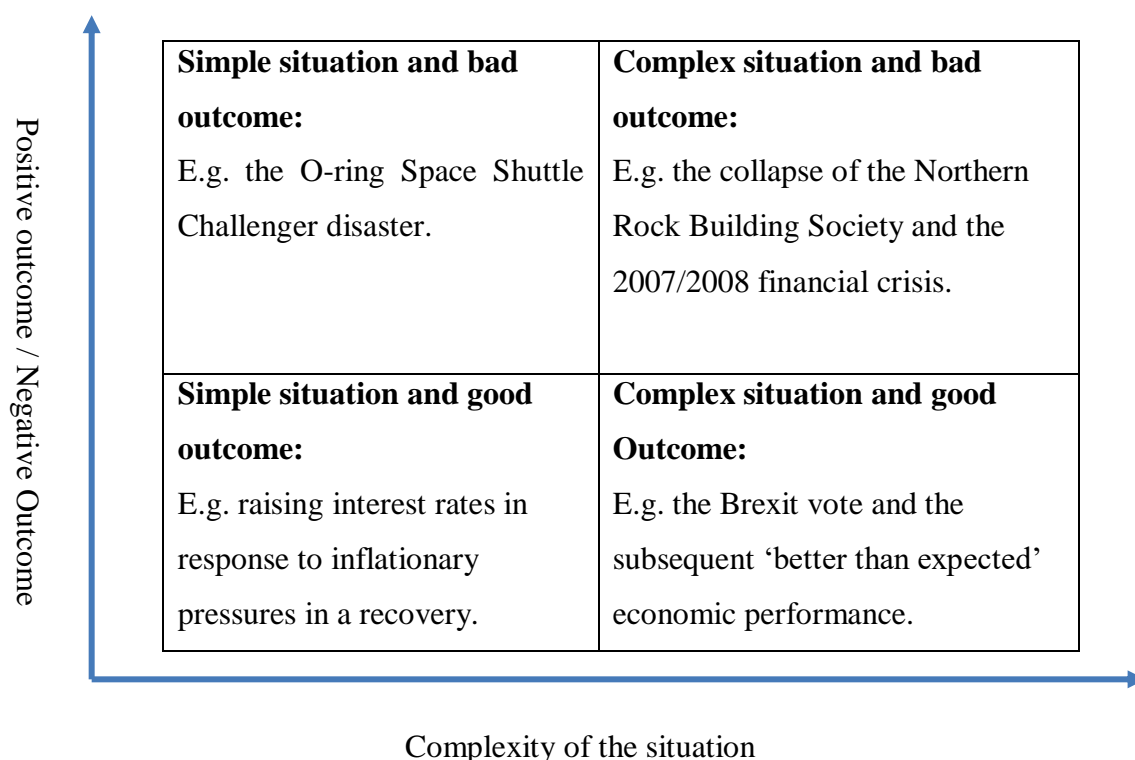
Similarly, most people believe that the 2007/2008 financial crisis triggered by the collapse of Northern Rock was a negative outcome, but the underlying causes may have been

more complex than any specific failure within that institution. Outcomes that are regarded as positive may, similarly, be deemed to have simple or complex underlying causes. That the outcome of the 2016 ‘Brexit’ referendum did not cause the economic havoc many had feared is a positive outcome, but this ‘better-than-expected’ outcome might have had complex causes, ranging from prompt policy intervention to global factors. In other cases, the positive outcome may be the result of a simple cause; for instance, an inflationary trend cut off by a timely increase in interest rates. This 2 x 2 dichotomy is summarised in the table below.

In the bottom half of the table, both outcomes are good and therefore whether they are complex or not, the central bank is not obliged to detail the implication of the outcomes and the consequences of their actions. For instance, with the better-than-expected labour market following the EU referendum, a number of complex scenarios could have contributed to the relatively positive outcomes; however, the Bank is not widely expected to account for these outcomes as they would if the outcomes had been worse. In the top half of the table however, both outcomes are worse whether the situation is complex or simple.

Summarily, poor outcomes warrant an explanation from those whose responsibility it is to control those outcomes. In other words, while the BoE is independent, it is required to explain deviations from the inflation target. Explaining negative outcomes in terms of simple causes would look like dereliction of duty or at least poor performance in any entity that had the responsibility of managing the economy and the resources to deliver on the responsibility. We would expect the Bank to favour complex explanations over simple ones. When the outcome turns out to be good, there is less reason to seek out complex explanations if simple ones will suffice. Our premise therefore is that the complexity of communication that we try to capture may be driven either by the complexity of the situation, as in the top right corner of the diagram, or by the negativity of the outcomes, as in the top left corner of the diagram.

Figure 1.2: Complexity of situations vs outcomes



Following on from the above, the need to understand whether the complexity of communication depends on the context in which the communication is made is also well described by Bulir et al. (2013). They consider two scenarios under which a central bank may be communicating and present the incentives for a central bank to communicate more clearly or otherwise in each scenario. In the first scenario, they describe a situation where persistent monetisation of debt has resulted in high inflation, and the expectations are for this to continue. In this case, the incentive to communicate clearly is limited because the causes of inflation are fairly obvious and likely to continue; furthermore, delivering a clear message is relatively easy. In the second scenario, there are several ‘offsetting’ and ‘difficult to measure’ factors driving inflation. This presents a difficult challenge for the bank to communicate about, however the potential gains (in terms of achieving its policy objective) from communicating clearly, via a well-crafted message, are much more than in the first scenario. Therefore, during complex economic situations, communication may become more challenging; nonetheless, the incentives to communicate clearly also increase.

It is important to note that when we capture the level of complexity of the Bank’s communication using readability statistics, we are simply highlighting the writing style in the communication as being clearly written or otherwise. Indeed, scholars such as Klare (1976),

who have extensively studied readability statistics, identify that these statistics generally capture the ease of understanding or comprehension of words and sentences due to the style of writing. This therefore implies that the writing style of communication can be distinct from issues such as context and coherence. Thus, the complexity of communication captured by readability statistics is in a greater sense an *attribute* of clarity and does not wholly imply clarity. To this end, our use of readability statistics as a yardstick of clarity is limited to attributes such as complexity, writing style and structure of communication. Similar to complexity, our analysis of tone looks into two dimensions, namely optimism and uncertainty, and uses a computer-aided textual analysis tool called Diction to extract values for these. As with the complexity of text, our values for optimism and uncertainty simply reflect the semantic features of the text rather than provide a full insight into the intentions of the texts.

Although understanding what drives the transparency of central bank communication is vital, there is also the further argument as to the onward effects of time-varying levels of complexity and tone of communication on the wider economy. As Blinder et al. (2008) highlight, there is a general consensus in the literature that ‘short run’ central bank communication (i.e. its views on the outlook for the economy and on monetary policy) have a significant impact on financial markets either via ‘creating news’ or ‘reducing noise’.

Following on from the above, the second section of our work therefore seeks to explore the onward effects of the complexity and tone of the BoE’s communication on a number of macroeconomic and market variables. Our ***two main research questions*** here address whether: (i) central bank communication transmits shocks to key macroeconomic and market variables environment and; (ii) whether communication significantly impacts volatility in financial markets.

Our null hypothesis was that central bank communication neither transmits shocks to key macroeconomic and financial market variables nor has any impact on the volatility of financial markets. Our findings on the onward effects of central bank communication are mixed. When we consider the effects of communication on financial market volatility, we align our work with the strand of the literature which suggests that more complex communication calms financial markets (e.g. see Geraats 2007, Ehrmann and Fratzcher (2007)) supposedly because market participants are reluctant to act without sufficient clarity from the central bank. The idea that that ambiguity calms markets does indeed have support within central banking practice. Alan Greenspan, the leading central banker once retorted, “...since I’ve become a central banker, I’ve learned to mumble with great incoherence. If I seem unduly clear to you,

you must have misunderstood what I said” (Alan Greenspan, as quoted in the Wall Street Journal, September 22, 1987).

We further hypothesised that increased optimism should reduce financial market volatility as suggested in the findings of Born et al. (2012). Certain strands of the literature, such as Li et al. (2005), that evaluate optimism of CEO communication and company stock volatility also present similar findings that suggest that optimism reduces stock price volatility.

Together, this part of our work which analyses the onward effects of communication on financial markets is termed the ‘front end analysis’ and provides an extension to our ‘back end’ analysis, discussed above. Figure 1.3 below provides a summary of our overall research questions as well as the linkages between the back and front end of our analyses.

Complexity

Is there an observable trend in the complexity of the Bank of England's communication over our sample period? (A1)

To what extent is the complexity of central bank communication affected by the prevailing macroeconomic environment? (A2)

A

Complexity

What are the effects of the complexity of central bank communication on key macroeconomic and market variables? (B1)

What are the effects of complexity of central bank communication on the volatility of financial markets. (B2)

B

Transparency & Accountability

Given the increased demand for transparency and accountability, is there an observable trend in the complexity and tone of Bank of England's communication over our sample period? (i)

Are the varying levels of complexity and tone of communication associated with the prevailing macroeconomic conditions in which the communication is made? (ii)

Does central bank communication transmit shocks to key macroeconomic and market variables environment? (iii)

Does central bank communication significantly impact volatility in financial markets? (iv)

C

Tone

How has the level of *optimism* in central bank communication varied over time? (C1)

How has the level of *uncertainty* in central bank communication varied over time? (C2)

To what extent is the level of *optimism* in central bank communication affected by the prevailing macroeconomic environment? (C3)

To what extent is the level of *uncertainty* in central bank communication affected by the prevailing macroeconomic environment? (C4)

D

Tone

What are the effects of shocks to *optimism* in central bank communication on key macroeconomic and market variables? (D1)

What are the effects of the level of *optimism* in central bank communication on the volatility of financial markets? (D2)

15

environment (front end analysis). These four key research questions are further broken down across the four quadrants labelled A to D. To the left of the diagram (in red) are the research questions (A1-A2 and C1-C4) relating to the back end analysis of our work while the front end analysis is explored via the research questions (B1-B2 and D1-D2) to the right of the diagram and in blue. Finally, the top half of the diagram (in yellow text) highlights the research questions related to the complexity of communication whilst the bottom half (in green text) highlights research questions related to tone.

To answer our research questions highlighted above, our work particularly focuses on carefully crafted communication documents which are shaped either through deliberation, as in the case of monetary policy committee (MPC) minutes, or through internal analysis at the bank, as in the case of inflation reports. Understanding what drives the time-varying complexity and tone of these documents as well as their onward effects on the macroeconomy not only helps provide some insight into the thinking of the Bank at any particular point in time, but also creates an avenue to conceptualise how monetary policy decisions may be optimal.

Our work extends previous research on the role of communication in monetary policy (see Blinder et al. 2008 for a foundational survey). First, while a majority (though not all) of this literature explores the role of communication for the US Federal Reserve, we focus on the Bank of England, which interestingly, was an early proponent of forward guidance. Second, we focus on using textual analysis of the BoE's communications to evaluate and quantify the complexity and tone of communication. We draw particular motivation for our study from the fact that textual analysis of central bank communication shows promise in terms of shaping monetary policy (see Bholat et al., 2015 and Shiller, 2017).

Our work seeks to contribute to the literature in three main ways. First, by exploring if the Bank's clarity and tone are influenced by the macroeconomic conditions during which the communication is made we can highlight how central banks communicate under varying macroeconomic scenarios (especially in unique periods such as during a financial crisis and in a zero lower bound environment), and contribute to the understanding of central bank behaviour in changing macroeconomic environments. Secondly, by exploring whether communication shocks are transmitted to these broad macroeconomic variables using a Factor Augmented Vector Auto-Regression model (FAVAR), we can contribute to the existing literature on the impacts of central bank communication on macroeconomic activity. Our intuition is that if communication is deemed to be an integral part of the monetary policy toolkit, then understanding the direction of shock transmission from communication to the macro environment becomes important, as has been well documented with interest rate shocks.

Particularly in a zero lower bound environment, exploring the direction of communication shocks and its impact on the macroeconomy become more crucial as central bankers seek alternative policy tools to help drive economic policy.

Finally, by exploring volatility transmission from central bank communication to the financial markets based on the complexity and tone used in communication, we can contribute to the literature on whether central bank communication mutes or increases volatility in financial markets. Understanding volatility transmission from communication is also vital in comprehending the onwads effects of communications made by central banks and helps to understand the implications of using communication as a policy tool.

We show that complexity and tone of communication are consistently impacted by inflationary pressures, although exchange rate pressures do matter over the longer term. Our main finding in this regard is that when the Bank is faced with what we define as a difficult macroeconomic condition, where inflation is rising and the value of the sterling is falling, the complexity of both MPC minutes and inflation reports tends to rise significantly. Overall, inflationary pressures seemed to be the dominant driver of complexity and tone across both MPC minutes and inflation reports, as rising inflation and a widening inflation gap were observed to reduce optimism in MPC minutes and increase uncertainty in inflation reports.

Furthermore, our results on shock transmission from communication to the financial and macroeconomic environment suggest that optimism shocks seemed to impact key variables in a way similar to interest rate shocks, despite controlling for interest rate changes. Specifically, following shocks to optimism in the Bank's communication, inflation falls, output falls, stock market returns fall, the pound rises in value and government bond yields rise. However, shocks to complexity were mixed, although these shocks seemed to consistently drive down stock and currency market values. Finally, we find that complexity and tone generally tend to have a limited effect on the volatility of stock, currency and bond markets; however, changes to optimism consistently drive down volatility in the stock and currency markets. The intuition behind these results as well as the support for our findings in the literature are well described in the latter parts of this work.

The rest of our work is structured as follows. Chapter two explores the related literature on central bank communication, monetary policy and textual analysis; chapter three explores our data-generating process in more detail. Chapter four analyses the impact of macroeconomic conditions on the BoE's communication; chapter five explores shock transmission from central bank communication to the macroeconomic environment; chapter six explores volatility

transmission from central bank communication to the financial markets and chapter seven provides a summary and conclusions.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction to central bank communication

Blinder et al. (2008) express that there has been a change in monetary policy thinking in both academia and central banking circles and there is now a generally accepted view that monetary policy is at least in part about managing expectations through communication. Central banks are increasingly using communication as an additional policy making tool. According to Woodford (2005), one of the most notable changes to the operation of the Federal Reserve occurred during the tenure of Alan Greenspan as Chairman of the Board of Governors, whereby there was a steady increase in the Federal Open Market Committee's desire to talk openly about the policy decisions it has made and those it is likely to make in the future. The transition from traditional monetary policy to inflation-targeting monetary policy driven by communication has been motivated by a number of factors, some of which are highlighted below.

Traditional monetary policy by central banks has always been targeted at keeping inflation at a level that the central banks deem acceptable. As Woodford (2011) points out, most industrialised countries did a good job of macroeconomic stabilisation through the 1980s and realised that by keeping inflation stable, they created a sound basis for real economic performance as well. What also became apparent after the 1980s was a new consensus by central banks to have monetary policy that was disciplined by clear rules rather than discretionary actions aimed at policy making. As Clarida et al. (2000) note, the Fed was highly accommodative before the pre-Volker years in the 1970s and only responded to anticipated inflation by letting short-term interest rates decline and raising nominal interest rates by less than the anticipated rise in inflation. What followed the Volcker/Greenspan years was a proactive response to anticipated inflation by systematically raising real and nominal interest rates as required. In line with rules-based policy making, more emphasis was given to explicit commitments to achieve desired economic outcomes, such as a target rate of inflation. Subsequently, many central banks in recent times have adopted a policy rule of inflation targeting which is best exemplified by the practices of the Bank of England, the Reserve Bank of New Zealand and the Swedish Riksbank.

Most monetary policy rules are interest rate rules in which the central bank adjusts the short-term interest rate instrument as a response to the current state of the economy. Taylor

(1999) explores a history of such monetary policy rules and concludes that generally monetary policy that stays close to the baseline policy rules will be effective. In recent times, there has been more exploratory work done on monetary policy rules with most of these relying on model-based approaches where private sector expectations enter the model explicitly. Very often, such models refer to forward-looking depictions of the economy (e.g. see McCallum and Nelson, 1999).

The main criticism of the Taylor rule is that the component data that go into the rule are not known with much accuracy until much later, therefore, the rule cannot be followed by the Fed ex-ante. Indeed, studies such as Orphanides (2001) have proven that although the Taylor rule rightly describes actual policy rate when ex-post data is used, it does not do so when real-time data is used to construct what the rule would have been at the point of policy making. Woodford (2001) also summarises a range of limitations to the Taylor type rules and policy rules in general, including the idea that they can lead to indeterminacy of the rational-expectations equilibrium price level.

Taylor type rules such as the ones discussed above are classified as instrument rules and are differentiated within the literature from targeting rules, which allow for more judgement in policy making. Svensson (2003) argues that targeting rules have a tendency to drive the economy to a more socially optimal equilibrium as they possess the ability to incorporate extra model information that is easier to verify than optimal instrument rules. Indeed, these arguments against the mechanical nature of instrument rules have a long history, with scholars such as McCallum (2000) suggesting that policy decision making under an instrument rule could be ‘handed over to a clerk with a calculator’ (p. 21). Svensson (2003) sought to bridge the gap between the instrument rules-based policy making and targeting rules-based policy and proposed a hybrid of prescribed policy guides which incorporates targeting rules as well as instrument rules. Furthermore, he argued that a monetary policy framework that used more of a targeting rule than an instrument rule would be desirable.

The most commonly advocated targeting rule is inflation targeting. Central banks such as the Bank of England and Riksbank of Sweden have in recent times set simple rules of thumb saying that interest rates should normally be adjusted to target a specific inflation forecast over a specific horizon (usually two years). The benefits of such a specific inflation target acting as the anchor for monetary policy are fairly obvious. Most importantly, it allows for clear accountability and as such an ex-post measure of the monetary policy success with the resultant effect of keeping inflation at low levels. However, Svensson (1997) identified the limitations to inflation targeting as being difficult to implement as central banks have imperfect control

over inflation, as well as inflation being affected by other factors outside monetary policy. Using an output stabilisation model, they argue that a simple solution to the problems of inflation targeting is to implement inflation targeting as inflation forecast targeting such that the central bank's inflation forecast is treated as an explicit intermediate target.

As Bernanke and Mishkin (1997) highlight, inflation targeting regimes are accompanied by the need for the central bank to publish regular and detailed assessments of the inflation situation and of their actions towards achieving the target as a means of ensuring accountability. It is within this mandate that communication by central banks has therefore become more prominent. In addition, as most inflation-targeting central banks primarily rely on their control of the base interest rate to adjust inflation expectations, the existence of a zero lower bound – where interest rates can go no lower – means alternative policy options will be explored. A combination of these two issues is the essential driving force behind the rise of central bank communications as a policy tool.

The question of whether communication has been an effective tool for monetary policy making has been debated extensively with no general consensus (see Blinder et al. 2008 and Svensson 2014 for a review). In fact, studies that go as far back as Barro and Gordon (1983) highlight that the reputation of central banks as perceived from their communication is central to effective rules-based monetary policy. The effectiveness of any communications-based policy will depend on the channels through which the communication is made (e.g. speech, policy paper, reports and policy meeting minutes) as well as the ability of the intended recipients to be able to obtain and understand the exact message being transmitted. These arguments have therefore driven the need to explore the various conduits through which effective policy communication can be made.

In practice, there are potentially a number of barriers to effective communication by central banks, but three main arguments have dominated the debate in recent times. First, and the most challenging of these, is the notion that there are barriers to transparency from the central banks themselves, i.e. the bank may choose to withhold certain information from market participants. This notion is further reaffirmed by the statements of Alan Greenspan quoted above. The literature on this issue also focuses somewhat on the credibility and reputation of central banks. Studies such as Faust and Svensson (1997) argue that increased transparency improves central banks' credibility and transparency; although many of these studies also highlight that full transparency may not always be in the interest of the bank despite the overwhelming social benefits of transparency.

Second is the idea that there are communication intermediaries that may obfuscate. For instance, when analysing the Federal Reserve's communication, Hayo et al (2008) found preliminary evidence that financial market news only comes into existence after it goes through a filtering process by the media, not necessarily at the time the information is made available by the central banks. This therefore implies that it is not enough for central banks to put communication out, but financial newswires also play a role in transmitting such information to the financial markets. With the rising phenomenon of 'fake news' interfering in economic and political discourse, this theme is becoming more entrenched in policy debate. Allcott and Gentzkow (2017) offer an economic theoretical framework for fake news by suggesting a model for media markets where 'firms gather and sell signals of a true state of the world to consumers who benefit from inferring that state' (p. 213). As customers cannot infer accuracy without incurring costs, fake news surfaces in equilibrium because it is relatively cheaper to provide than precise signals. Therefore, to the extent that there are costs associated with market participants obtaining precise signals from a central bank, there exists the risk of fake news in the discourse of central bank policy and subsequently obfuscation of the communication channel.

The third source of complication is that market participants may themselves misinterpret the policy message being directly transmitted by the bank due to a lack of clarity or misunderstanding of the tone of communication. This body of research deals with detailed analysis of the contents of communication using various approaches and tries to make qualitative and quantitative inferences from these. Within this school of thought, scholars have quantified communication-based on their existence in the first place, for example the number of communications released (see Woodford, 2005); or based on their tone, e.g. in terms of optimism or negative/positive tone (see Born et al. 2012, Hansen and McMahon, 2016) or based on their clarity (see Bulir et al. 2013). The front end analysis of our work mainly draws inspiration from this third notion and explores the contents of communication for clarity and various tones, including how these go on to impact macroeconomic variables. In line with the notion described above, our work argues that variations in clarity and tone in the process of transmitting policy communication can have a significant impact within a policy environment.

Given the multifaceted challenges in using communication as a policy tool as described above, and the need to derive an optimal communication policy, central banks have increasingly focused on understanding the role that communication plays in their policy toolkit. Most modern central banks have evolved in their pursuit of an optimal communication policy and the Bank of England is no exception. Therefore, understanding the evolution of central

banks over the years is vital in contextualising how communication can shape policy. The next section of our literature review thus explores a background to the Bank of England with a specific focus on its evolution over time.

2.2 The Bank of England

Our analysis of central bank communication in this research mainly focuses on the Bank of England for a number of reasons. First, the BoE, along with the Reserve Bank of New Zealand and Riksbank, was one of the earliest central banks to adopt an inflation-targeting regime, which therefore required increased use of communication as a policy tool. Secondly, most of the research done on central bank communication as policy tool has focused more extensively on the Federal Reserve in the US as well as on the European Central Bank (ECB) with relatively less attention on the BoE.

Since the BoE was founded in 1694 to help raise bullion following defeat to France at the Battle of Beachy Head, the role of the Bank has steadily evolved over the past few centuries. Notably, the postwar era up until 1975 saw a period of rising inflation which particularly made the role of the bank in policy making more prominent and questionable at the same time. As King (1997) highlights, policy framework during this period reflected the absence of a credible monetary regime, which was demonstrated by the instability of the short-run Phillips Curve during this period. He argued that during this period, the long-run trade-off between unemployment and inflation was absent and neither was there a stable natural rate of unemployment. What followed the foregoing over the next 20 years or so was a quest for a nominal framework that would provide some credibility for the Bank's commitment to low inflation anchored by a specific price level target. Although some targets for monetary aggregates were introduced in the 1970s, these were disbanded in the 1980s due to large and unpredicted changes in the velocity of money.

The next major shift in policy framework for the Bank was the UK's participation in the European Exchange Rate Mechanism (ERM). A number of events across Europe following the UK's joining the ERM in October 1990, up until its withdrawal in 1992 made the Bank's success within the ERM difficult. Buiter et al. (2001) summarise two major causes of the failure of the Bank's policymaking within the ERM. First were the significant macroeconomic and political fundamentals across Europe, such as German reunification, which meant that policy changes abroad had a significant impact on local policies. Secondly, the liberalisation of the international financial markets under the Single European Act and the subsequent weakening

of national policy makers' resolve to withhold fixed exchange rates following the Danish referendum in June 1992 also contributed to the failure of the ERM.

The departure from the ERM prompted the Bank to focus on domestic targets as a base for monetary policy. In October 1992, a new policy framework with two main components was introduced. The first required interest rates to be set in order to help attain an explicit target for inflation which was initially set at 2.5% and secondly, there were a series of institutional measures that afforded the bank more responsibility for setting interest rates. These inflation-targeting measures started the regime of increased transparency at the Bank, which was followed by lower inflation rates. Indeed, in 1993 the BoE was one of the few central banks that started openly publishing inflation reports making it one of the leading proponents of transparency across the world. The inflation reports were produced to provide a regular report on the progress being made towards the government's inflation objective. Although the Bank also experienced somewhat increased independence following these measures, this was still limited, given that the Bank still did not have the power to set interest rates; this was set by the Chancellor of the Exchequer. During this period, interest rate decisions were made by the Chancellor following a meeting with the central bank Governor after advice had been given to the Chancellor by the Governor.

On the 6th of May 1997 however, the recently-elected Labour government granted full operational independence to the Bank. This new macroeconomic policy environment implied that the Bank now had full powers to set interest rates and drive macroeconomic policy towards the set inflation target. The prerogative for setting interest rates now lay with a nine-member monetary policy committee (MPC) which consisted of five members from the Bank itself (the Governor, two Deputy Governors, the Chief Economist and the Executive Director for financial market operations) and four external members, who were mainly chosen from industry and academia. The inflation target, as well as the threshold that triggers a letter to the chancellor if the threshold was breached, was still set by the chancellor, however. This new monetary policy framework further increased accountability and transparency of decision making within the bank and prompted further measures of transparency, notably, the publication of MPC members' voting records and of MPC minutes. Although meeting minutes between the chancellor and the Bank of England's Governor had been published in the past, they did not provide as much signal for the future direction of monetary policy as did the new MPC minutes. One could understand why this was the case because the Chancellor had the ultimate prerogative to change interest rates and as such their moves were less predictable and could be politically motivated. This period therefore heralded an era where communication

from the Bank became vital as market participants looked to obtain signals from the bank's monetary policy discussions.

Under the new independent macroeconomic policy framework, these monthly MPC minutes included discussions about the Bank's policy making during the meetings along with its perception of its current and future macroeconomic stance. MPC minutes were often released no later than six weeks after each monthly meeting. Notably, these minutes also included an appendix that was attributed to the Bank's staff and provided a summary of facts and figures providing justification for the Bank's policy decision making. This added another layer of transparency in the sense that justifications of decision making helped market participants better understand the thinking of the Bank. However, in December 2004, the Bank withdrew this appendix section from the MPC minutes, citing a survey conducted by Bank staff that suggested that this section was not useful to market participants.

As the Bank gained increasing independence, and following the financial crisis of 2008, concerns began to arise about the level of accountability and transparency at the Bank. These concerns were particularly escalated as the Bank gained increasing responsibility for monetary stability, financial stability and microprudential regulation. Notably, in 2014, the Treasury Select Committee led by Andrew Tyrie demanded that the Bank review its transparency and accountability practices. The foregoing led to the development of a strategic plan by the Bank which had 'openness and accountability' at the core of the Bank's mission. Later that year, the Bank commissioned Kevin Warsh to carry out an independent review of transparency practices at the Bank and a number of recommendations were made that would primarily change the way in which the Bank communicated and was governed. The most notable change in terms of communication was that the MPC would now publish the full written transcripts of the meetings at which monetary policy was decided as well as a policy decision and inflation reports (where relevant) at the same time as a policy decision. The aim of this was to remove the 'drip-feed' news and ensuring that policy decisions are as clear as possible. Other recommended changes also included changes to meeting frequencies and governance structures

In this study, we focus mainly on the monetary policy regime from when the Bank became independent in 1997 as this is a significant period where communication began to play an important part in policy. Indeed, studies such as Clare and Courtenay (2001) compare the market reaction to BoE communication pre- and post-BoE independence and find evidence that financial markets seemed to react more to the Bank's communication following its independence. Our sample period ends in July 2015 given that the implementation of the recommendations of the Warsh review, which made significant changes in the Bank's

monetary policy framework and transparency, began in August 2015. Over this period, we explore 214 monetary policy communications as well as 75 inflation reports. MPC minutes and inflation reports often contain in-depth analysis of the factors that drive monetary policy including issues surrounding output and demand, money and credit, financial markets and the international economy. These documentations are therefore a relatively accurate reflection of the BoE's monetary policy stance at any point in time.

2.2 Central bank communication as a policy tool

Although the notion of central bank communication becoming an integral component of a central bank's monetary policy tool kit has been around for a few decades, the literature on central bank communication is still relatively scant compared to other macroeconomic policy tools. There are two main strands which are often identified in the literature. The first of these evaluates the impact of communication on financial markets and the macroeconomy either through the occurrence of such communication or a content analysis of the communication (e.g. see Glick and Leduc, 2012 and Hansen and McMahon, 2016). This works mainly through understanding how communication can effectively drive expectations which should then optimally drive asset prices and macroeconomic fundamentals. Blinder et al. (2008) argue that such expectations are managed by using communication to 'create news' and 'reduce noise'. The second strand seeks to explore the various communication strategies used by central bankers and attribute these to policy making and economic performance (e.g. see Eusepi and Prestion, 2010). In understanding these developments in the literature, however, it is fundamental to understand the new role of communication in central bank policy making and the vast amount of literature that has preceded this.

Monetary policy involves driving interest rates and yields on financial assets in a way that impacts economic activity to desired levels. One conventional way of doing this involves central banks changing the short-term policy rate to meet desired expectations. The theory of the term structure of interest rates suggests that the longer-term interest rates should reflect the expected sequences of future overnight rates (see Cox et al. 1985). Therefore, as a means of driving longer-term economic policies, central banks will seek to influence future paths of overnight interest rates and not simply their current levels. The model highlights that policy expectations about the future path of interest rates are the main determinant of current long-term interest rates under a rational expectations framework. As is widely argued, few, if any

economic decisions are hinged on the overnight rate, therefore explaining the reasoning behind the longer-term view of interest rates.

Generally, it is perceived that to a large extent, short-term changes in interest rates by central banks are expected to change expectations about the direction of long-term interest rates. However, a problem arises under the zero lower bound situation where lowering the policy rate is not feasible any longer. In such a scenario, it has been widely established within the literature that central banks should then seek to drive monetary policy by influencing the expectations of market participants through communication of the future path of short-term interest rates (see Eusepi and Prestion, 2010).

Bernanke and Reinhart (2004) argue that under these conditions, additional policy stimulus can be imparted by offering some form of commitment to the public about the future path of the short-term rates. The above mechanism of driving monetary policy through expectations of the future interest rate path is what has now become widely known as forward guidance. As defined by Levin et al. (2010), forward guidance is simply an approach that suggests that policy makers should make announcements on the future path of policy rates.

To further explain the role of communication within the modern-day monetary policy framework, Blinder et al. use a simple macroeconomic framework. Under this framework, they assume that aggregate demand in an economy depends on the short-term rate r , the long-term rate R and expected inflation (π) amongst a host of other factors which do not need to be identified explicitly. Therefore:

$$y_t = D(r_t - \pi_t^e, R_t - \pi_t^e, \dots) + \varepsilon_{2t} \quad \dots (2.1)$$

The equivalent aggregate supply relation could resemble the new Keynesian Phillips curve:

$$\pi_t = \beta E(\pi_{t+1}) + \gamma(Y_t - Y_t^*) + \varepsilon_{3t} \quad \dots (2.2)$$

Where π_t measures inflation, Y_t measures real output and Y_t^* measures potential real output.

A Taylor rule similar to the one below could then be used to close out the model:

$$r_t = G(Y_t - Y_t^*, \pi_t, \pi_t^*, \dots) + \varepsilon_{4t} \quad \dots (2.3)$$

If we assume a scenario where equations 2.1 and 2.2 do not change over time, then this will imply that the economic environment is stationary and therefore expectations will be

completely rational. In such a scenario, the central bank will be said to be credibly committed to following an unchanging policy rule, as in equation 2.3, and therefore communication will be totally irrelevant as a policy tool. Under this condition, following the popular definition of transparency as the goals of the central bank being fully deducible via available data (e.g. see Faust and Svensson, 2001), the central bank can be said to be fully transparent without necessarily communicating.

Blinder et al. (2008), however, identify four scenarios within the above framework where central bank communication begins to matter. They identify these as: (i) where non-stationarity exists, either of the economy or of the policy rule; (ii) where learning within the economy disrupts ability to predict the policy rule in some way; (iii) where non-rational expectations exist with economic agents; and (iv) where there is asymmetric information between the public and the central bank. Given that these realistic scenarios exist in the real world, central bank communication begins to matter.

Using a Ricardian model that associates each possible current inflation rate with a short-term interest rate and the future short-term interest rate, which is expected to prevail for a sequence of time periods into the future, Magill and Quinzii (2014) developed a forward guidance rule. They argue that mathematically, the forward guidance rule is similar to the term structure of interest rates in that expectations can be analysed in the same way and the same conclusions reached. Using a rational expectations framework, a number of researchers have also gone on to evaluate the effects of forward guidance policies on long-term interest rate expectations (e.g. see Moessner (2013) and Anderson and Hoffman (2009)). Theoretically therefore, central bank communication replaces short-term interest rate changes and expectations under a rational expectations framework and hence its importance as a monetary policy tool under zero lower bound environments.

Despite the popularity of the rational expectations theory of the term structure of interest rates as a determinant of long-term interest rates, its validity has often been debated. For instance, Shiller et al. (1983) using post-war data on the three-month and six-month Treasury Bills, seem to highlight the ‘worthlessness’ of the model whilst suggesting that a ‘tail wags dog’ theory in which long-term interest rates tend to overreact to current information is more appropriate. They argued for the absence of long-term predictive information in the spreads of three-month and six-month rates. Conversely, Mankiw et al (1987) used pre-war data to explain that the loss of this predictive ability primarily stemmed from the founding of the Fed in 1914 and its role in stabilising the three-month rate by inducing a random-walk behaviour. Later studies such as Rudebusch (1995) found disparities in the effectiveness of the

spreads of short-term and longer-term rates in predicting future rate changes. The study found that overnight spreads and short term interest rates have predictive information while medium-term and longer-term spreads have no predictive information.

According to Campbell et al. (2012), forward guidance communications can be categorised by the extent to which they are Delphic or Odyssean, in the classical Greek sense. Examining public statements of FOMC intentions, they distinguish between Delphic communication. Which provides information about the FOMC's view of the future. And Odyssean communication. Which publicly commits them to a future action. They liken Delphic communication to instances where the central bank uses uncertain phrases such as 'an extended period' or 'some time in the near future' with no clear time commitment of a policy action. Odyssean communication however would replace such phrases with hard deadlines such as 'mid-2014' or 'the end of 2015'; an analogy similar to Odysseus committing himself to staying on his ship by having himself bound to the mast whatever the case. Hansen and McMahon (2016) argue that such distinctions are not without controversy and they therefore ignore the need for such differentiations in their analysis of the Fed's forward guidance policy.

Although the literature in favour of the quantitative justification of a forward guidance policy is scant, there is quite a rich literature on its theoretical justification. Using an estimated DSGE model, Campbell et al. (2012) find that 'surprises associated with FOMC policy announcements substantially influence Treasury bond rates, corporate borrowing rates, and private macroeconomic forecasts' (p. 51). In some counterintuitive manner, however, they also found that communication about substantial monetary tightening raises interest rates as desired, but simultaneously increases inflation forecasts and decreases unemployment forecasts, somewhat reflecting the forward guidance puzzle. Other studies such as Kool and Thornton (2012) have found that forward guidance can be very effective in preserving macroeconomic stability and many central banks in developed economies have been quick to adopt this mechanism as a means of tackling contractionary demand pressure.

Hoffman and Anderson (2009) identify that the primary advantage of a central bank publishing its own policy path is that it would help steer expectations within the financial markets and help reinforce macroeconomic policies being administered. Most of the work done on forward guidance has focused on its effectiveness in directing the future path of short rate as well as its effects on asset pricing (e.g. see Kool and Thornton, 2012). However, the notion that forward guidance is an effective means of monetary policy is primarily borne out of the idea of monetary policy being transparent, which is suggested to increase the efficacy of policy making (see Geraats, 2002). In line with this, a new raft of literature on the role of transparency

as a means of effecting monetary policy is being advanced and, with it, other issues such as clarity.

On the contrary, more recent work such as that of Campbell et al. (2017) which evaluates the effectiveness of the Fed's forward guidance through the 2008 financial crisis period, has argued against the effectiveness of forward guidance when compared to a purely rules-based policy. Using an estimated medium-scale New Keynesian model to perform a counterfactual experiment between 2009q1–2014q4, they found that a simple rules-based policy would have delivered a better outcome in the years following the financial crisis. They nonetheless argued that with the introduction of the calendar-based communication whereby the policy maker communicates that the policy rate will be held at a fixed range irrespective of the state of the economy, the Fed was able to move inflation closer to target and boost real economic activity.

McKay et al. (2016) argue that the perceived inefficacy of forward guidance may be down to the notion that forward guidance is highly sensitive to the assumption of complete markets. They argue that agents may not respond to perceived changes in future interest rates so long as they face uninsurable income risks and borrowing constraints. Del Negro et al. (2013) highlighted the concern that standard medium-scale DSGE models wholly overstate the effects of forward guidance on the economy as the 'forward guidance puzzle' identifies. They proposed the use of an alternative DSGE model where they constrain the overall impact of forward guidance on longer-term rates rather than short-term rates, which forward guidance seeks to influence.

Furthermore, over the past few years there has been some research that has sought to explain monetary policy effectiveness using adaptive learning. Under an adaptive learning approach, agents are assumed to have only limited knowledge about the structure of the economy and therefore run reduced form regressions which, as time goes on and economic data changes, make them change their forecasting rule (Gaspar et al. 2006). As Blinder et al. (2008) highlight, Bernanke (2004) used this idea of adaptive learning to explain the role of communication in monetary policy effectiveness. He argued that given that the public does not know and instead must estimate the central bank's reaction function using publicly available information, there is no guarantee that the economy will converge to the optimum rational expectations equilibrium.

To better understand the role of learning, Orphanides and Williams (2005) built a theoretical model in which the public is assumed to know the underlying structure of the behaviour of economic policy but do not have explicit quantitative magnitudes describing that

structure. Under such a model, therefore, private agents are forced to parse the central bank's communication in order to be able to fit quantitative/qualitative information into their models. They found that such a model follows a time-varying process and provides useful information for the conduct of monetary policy. Eusepi and Preston (2010) argue that under a learning economy, expectations are unanchored because all private agents face difficult forecasting problems. Therefore to mitigate this, central banks should put out communications to align expectations towards the policy rule that agents are learning about and should do so in a clear and transparent manner. The following sections of this chapter evaluate the literature around the clarity and transparency of central bank communication.

2.3 The role of intermediaries in central bank communication

Over the years, increased demand for accountability and transparency have driven a growing need for communication by central banks, which in turn has intensified news coverage of such communication. With such a flood of information as well as other financial information coming through, economic agents have been forced to rely on news sources (often financial newswires) to filter communication that is relevant to their financial decisions. An additional layer of complexity is the speed and rate at which news is made available to the markets due to improved technology. Within the central bank communication literature, most studies that explore the impact of central bank communication do not necessarily focus on the primary communication from the central banks but on the interpretation and dissemination of such stories by newswire services.

Although there has generally been some focus on information transmitted via financial newswires as these are perceived to be closely monitored by active market participants (e.g. banks other financial institutions), it is important to note that all information transmitted to the public via all sources is vital for policy making. Indeed, Berger et al. (2011) argue that information reaching the general public is more crucial than information only reaching financial market participants. They highlight that 'it is the public whose inflation expectations eventually feed into the evolution of inflation through wage claims and savings, investment and consumption decisions' (p. 14).

Ehrmann and Fratzscher (2007) identify that as effective communication becomes a primary monetary policy tool available for central banks at the zero lower bound, it is important that the channels through which these communications reach consumers of the information is explored as well. Particularly, when analysing central bank communication, they argue for the

use of newswire reporting as provided by newswires such Reuters, rather than direct communication from the central banks. They suggest that newswire reporting helps analyse central bank communication from a market perspective, i.e. the actual communication that market participants receive. Additionally, because guidance typically involves the central banks putting out communications that signal the future path of policy rates, the language used in these communications is very important. With central banks continuing to explore these non-conventional monetary policies, the bigger question is whether such policy communication and transparency by central banks are effective if the right information does not reach the target market participants.

Hayo et al (2008), whilst analysing the Federal Reserve's communication, found preliminary evidence that financial market news initially goes through a filtering process by the media and these items of news often only become available to the public after this process. More importantly, he argued that the impact of the news is not necessarily at the time the information is made available by the central banks, but at the time the consumer obtains this from the newswires. Hayo and Neuenkirch (2012) argue that to cope with the volume of financial market news, individual agents simply ignore relevant information, probably because it is costly to acquire, and only depend on information filters from newswires. This therefore implies that although central banks may seek to publish information for public consumption, the filtering process by news intermediaries may distort both the timing and clarity of the information being provided.

These arguments create a vital case for understanding the role of financial newswires in policy transmission. In trying to work out how market participants process central bank communications, Hayo and Neuenkirch (2015), using a survey of 450 market participants from around the world, found that respondents rely more on newswire services to learn about central banks communications than self-monitoring the central banks. Lucca and Trebbi (2009) also found that financial market participants pay very close attention to the financial market press, such as the recurring *Wall Street Journal* column 'Parsing the Fed', which analyses the content of each sentence of the statement relative to the most recent one 'for clues about where interest rates may be headed' (p. 3). Additionally, Berger et al. (2011), using a novel dataset that quantified press coverage in the 12 countries of the euro area and internationally, found that the media tends to report ECB policy decisions where inflation exceeds the inflation target more negatively than the bank intends. They also found that where there exists frequent inter-meeting communication by the ECB, the media seemed to report with a more positive tone.

There are also several instances where it has been found that central bank communication, if not clearly delivered, may transmit the wrong signals to the market and hence induce volatility. Sicilia and Cruickshank (2000) studied Alan Greenspan's speech, a phenomenon they called the Greenspan Effect, and found that his speeches, particularly his congressional testimonies, had a significant impact on financial markets and had the ability to calm investors as well as stabilise world currency markets. However, they also found that in some instances, when Greenspan's speech was vague, it generated a ripple effect that was caused by newswire services misconstruing the true meaning of his speeches, as in the case of his 1996 'irrational exuberance' comments, which was parsed into an 18 page discussion from his original 31-word sentence. Furthermore, as central bank communication is intended to correct faulty expectations whilst reducing misallocation of resources, inaccurate interpretation might actually induce such misallocation; 'e.g., if agents make economic decisions such as taking on a mortgage based on the central bank's communication' (Blinder et al., 2008). When communication is properly transmitted by new channels therefore, these news channels not only act as filtering mechanisms but also as a debriefing and interpreting channel.

Some of the previous literature that has discouraged elements of central bank communication have done so with the justification that it is susceptible to misinterpretation by the public. Mishkin (2004) has argued against fully communicating the future path of central bank policy on the grounds that it may complicate the bank's decision-making process because the public may not accurately interpret the conditional nature of the projections. Blinder et al. (2008) also argue that central banks often hold back from fully communicating their actions because it may be mistaken for commitment. This, of course, is even more accurate if financial newswires pick and choose which information they pass on to the general public.

There is indeed some evidence that central bank communication processed via newswires may tend to confuse markets in some ways. Hayo and Nueunkirch (2012) analysed the effects of the FOMC's communication on the financial markets and used a database of actual FOMC communication to compare the results to those carried out using the database created by Ehrmann and Fratzscher (2007), which uses newswire reporting of FOMC communication. They found that regressions using newswire reporting revealed fewer significant coefficients and contained unexpected signs, therefore suggesting that actual central bank communications were more significant in impacting financial markets.

In recent times as well, there has been the expanding phenomenon of 'fake news' and its role in policy communication. Although more common in political satire and press

metacoverage within journalism, ‘fake news’ is now a more cross-contextual issue. Within journalism, there are valid arguments for advocating fake news as supported by the concept of the Stewart/Colbert effect, where political satire (fake news) has been used as a genuine transmission mechanism for real news (Amarasingam, 2011). Brewer et al. (2013) also argue that regular satire viewers may have stronger opinions on real news issues if they had previously encountered it in satire programming.

Within the context of economics. However, there seems to be a different view on fake news which is a relatively newer concept requiring analysis. Allcott and Gentzkow (2017) define fake news as ‘news articles that are intentionally and verifiably false, and could mislead readers’ (p. 213). As a way of offering an economic argument for the news market, Gentzkow et al. (2014) developed a model for media markets where a continuum of consumers and a limited number of media firms observe and report independent signals. Their model considers fake news to occur as a result of either filtering bias or distortion which are often driven from the supply side through internal and/or external pressures. Internal pressures are in the form of direct preferences of media owners or preferences of the reporters and editors. On the other hand, external pressures may be in the form of pressure from governments, advertisers and other third parties. They conclude that when distortions in communication originate from the media firms’ incentives to build a reputation for quality, ‘the availability of information from competing sources may allow consumers to distinguish true quality more accurately, and so reduce bias by softening these reputational incentives’ (p. 25). In the case of central bank communication, supply-side bias in the form of any of the above will have serious implications for the transmission of policy news.

Demand-side bias also exists, where consumers look to obtain news from sources whose bias matches their own prior belief. Indeed, the whole basis for physiological utility from media consumption as described by various studies (e.g. see Nickerson 1998; Rabin and Schrag 1999; Tirole 2002) supports this argument.

Using a similar economic model to the one above, Allcott and Gentzkow (2017) argue that fake news arises in equilibrium because it is cheaper to both provide and obtain than precise signals. Their analysis extends the market analysis from simply considering the mainstream media to also evaluating the role of social media in fake news. They argue that social media particularly increases the occurrence of market failures in the media market as the barriers to entry are extremely low. The danger of this, therefore, is that a journalist or any other individual can supply fake news to the market with significant impact if there is a demand for their biases. A simple case of an individual misinterpreting a statement by the central bank, for instance,

therefore becomes potentially more dangerous than ever before, especially if their reach is to millions of followers, as in the case of Twitter. As Allcott and Gentzkow (2017) highlight, to the extent that social costs are created by such demand and supply mechanisms, eliminating market failures becomes a priority, especially as social costs in the case of policy misstatements may lead to investment losses for small scale retail investors. This is particularly important in scenarios where many small-scale investors, such as retail traders, are increasingly obtaining their market information from online sources.

An apposite example of the role of media outlets in policy debate is the events of July 28th 2017 where the pound surged to a one year high (post-Brexit vote) following comments by Mark Carney that ‘Some removal of monetary stimulus is likely to become necessary if the trade-off facing the MPC continues to lessen and the policy decision accordingly becomes more conventional...’ Given that a few journalists were quick to point out that Mark Carney had never voted in the minority (currently the ‘Hawks’), the headlines report across media outlets suggested a rise in rates was imminent. Notably, Chris Giles of the *FT* Larry Elliot of *I Guardian* and Jamie McGeever of Reuters all put out affirmative reporting on Mark Carney ready to raise rates. This frenzy in the market was later followed by a clarification from the Bank that the same conditions (as has always been stated) in relation to wage growth and Brexit would suffice for a rate rise to be imminent, therefore sending the pound value back down. This becomes more interesting indeed as Mark Carney had only committed to keeping rates on hold a week before with an affirmative statement saying “now is not the time” to raise rates.

Similarly, in a bizarre turn of events, on the same day the ECB was forced to clarify a statement made by Mario Draghi which had been misreported by the media. The ECB subsequently stated that ‘... President Mario Draghi intended to signal tolerance for a period of weaker inflation, not an imminent policy tightening...’. Nonetheless, the Euro had already witnessed a sharp decline as at the time the statement was released. In line with Gentzkow et al. (2014), the reporting of these statements showed a media bias from the supply side driven by the interpretation of reporters and editors.

These kinds of events become of great importance to policy makers mainly because certain individual market participants do not necessarily need the credibility of the big newswires to impact markets. For instance, reporting by media outlets such as MarketWatch,¹ which identifies individuals such as investor, blogger and columnist Jeroen Blockland – who has just over 13,000 followers (as at July 2017) – as being ‘on a list of Twitter accounts that

¹ MarketWatch is a subsidiary of Dow Jones & Company and operates a financial information website that provides business news, analysis, and stock market data.

investors need to follow’ reinforces the powers of individuals in influencing market opinions. Generally, these examples strongly reaffirm the role that the media can play in influencing policy communication.

In summary, there is evidence that communication intermediaries have a tendency to both clarify and distort information coming from the central banks and there is no consensus on their role in the effectiveness of policy communication. On the basis of the foregoing, it is important for studies like ours to explore the original communication from central banks in a bid to understand the fundamental drivers and reactions of the original communication. Acosta (2015) documents evidence that supports the notion that the public pays direct attention to information released by central banks by reviewing Google search results for ‘FOMC statements’ and showing that there has been an increased trend in the search for FOMC statements on Google. He notes that peaks in interest in the terms coincide with the release of the minutes of FOMC meetings. Our findings can contribute to a better understanding of the role that communication intermediaries play in central bank policy communication.

2.4 Central bank transparency: theoretical background

The role of transparency in effective communication, and subsequently effective policy making, has been explored via various means. Early works done on measures of transparency such as that of Leiderman and Svensson (1995) and Bernanke et al. (1999) focus on the extent to which inflation targeting has been met as a measure of transparency. Other studies such as Fry et al. (2000) and Blinder et al. (2001) used surveys of central bank practices to evaluate the extent to which central banks are transparent. Eijffinger and Geraats (2006) highlight five main types of transparency that can be evaluated in central banks, namely political, economic, procedural, policy and operational transparency. To date, there is no generally accepted measure of transparency and many of the studies that measure transparency will often do so using one of the broad ideas above or a combination of these. Some studies, such as Bernanke (2001), simply use an inflation-targeting framework that measures the degree of divergence from the central bank’s inflation target as a measure of transparency, whilst studies such as Horvath and Vasco (2016) and Eijffinger and Geraats (2006) use a combination of inflation-targeting measures and provision of information amongst other sub-measures.

In the simplest terms, the definition of transparency is that of Geraats (2002). It defines transparency as the absence of asymmetric information between monetary policy makers and economic agents. Simply put, transparency in monetary policy can be defined as the degree of

openness exhibited by a central bank in the course of their policy implementation. In practical terms, therefore, a transparent central bank is one which seeks to openly communicate its thinking and future policy path, and this is why communication dynamics becomes an important part of central bank transparency. The broader components of transparency identified by Eijffinger and Geraats (2006) are arguably the most commonly used definitions of transparency and have been used in more recent works such as Dincer and Eichengreen (2014) and Hovarth and Vasco (2016). The above variation in definitions is a clear indication that ‘transparency’ in its broad sense will mean different things to different individuals.

Furthermore, there is a dichotomy in beliefs on transparency in this regard that should be noted here. Many academics call for increased transparency in the form of more communication on governing council meeting minutes, reports, voting records, speeches and so on as a means of increasing accountability by central banks. On the other hand, commentators such as market participants view transparency in the form of providing all relevant information that is useful for financial decision making and not necessarily all information the bank is capable of providing. Therefore, for some, central banks talk too much whilst for others central banks talk too little, hence the need for an optimal level of transparency has been argued for in the literature. Whatever side of the divide one is on, however, the quality of whatever communication the banks release should be a fundamental requirement for effective transparency. Given that communication is a two-way street, a central bank may be ranked as highly transparent from their point of view by the basic definition of openness used in much of the literature; however, this transparency may not be effective given that the quality of openness is poor. The idea of transparency in action should therefore be distinguished from effective transparency.

Woodford (2005) sought to establish to what extent it is desirable for central banks to communicate policy decisions. He argues that communication by central banks often falls within two main contexts: first is the signalling effect of the information released through monetary policy committee meetings such as the FOMC in the US and the BoE in England, and second is the willingness of central banks to share their assumptions on the future course of the economy. Our research is more related to the former, i.e. the signalling effect of monetary policy communications through channels like minutes and reports. The general notion in the literature is that for effective signalling of the future path of policy rate, communication made by central banks regarding this must be transparent.

Generally, extensive transparency of central bank communication has not always been seen as desirable within the literature. Studies such as Morris and Shin (2002) have argued that

there are socially beneficial limits to central banks putting out public information. They argue that although increased public information is valuable to economic agents where no socially viable private information is available, the benefits of such public information become ambiguous when agents have independent sources of information. Walsh (2007), used a quadratic loss function to demonstrate the extent to which information from central banks should be made public. He argued for an optimal level of transparency which is driven by costs and demand disturbances whereby the banks forecast these disturbances and release information as a response. Issing (2014) posits that given that central banks communicate a lot of information, ‘If the information is too noisy, too uncertain, and if the risk is high that the public might be distracted, it might be better to restrict communication’. He argued that information such as underlying uncertainty associated with a forecast has a tendency to be misunderstood by the public.

The idea of an optimal level of transparency is also supported by van der Cruijsen et al. (2010), who argue that beyond the optimal level of transparency, agents might attach too much significance to the conditionality of their forecasts and could become confused by the increasing amount of information they receive. Additionally, from a practical perspective, Blinder et al. (2008) highlight that even central banks that publish a good amount of communication still often keep internal deliberations secret and often observe a ‘purdah’ period before key meetings. As with the arguments for an optimal level of transparency within the theoretical literature, there are arguments for limits to transparency in the practical world as well. For instance, Ehrmann and Fratzscher (2009a) argue that the purdah is necessary around meeting days as communication during the purdah has been observed to excessively raise volatility within the financial markets. Contrasting purdah day communications with normal communication after the FOMC’s meetings, they found that post FOMC statements led to a significant drop in market volatility.

Another interesting perspective on the limits to central bank transparency is the argument about whether transparency is a beneficial element in principal-agent relationships between the bank and the public. This argument is central to the works of Prat (2005), who uses the model of career concepts for experts to highlight the role that career concerns and reputation plays in driving transparency. Applied to central bank communication, Prat’s work argues that central bankers as agents of the public (who are principals) receive a signal about the state of the world (or the economy) and will act based on those signals on behalf of the principals with a subsequent consequence. He argues that the principals will benefit significantly from information about the action that the agent took and information about the

consequence of the agent's action. In this model, full transparency is linked to fully understanding the agent's actions and the consequences of those actions; direct information on the agent's action thus has a potentially positive effect on the principal (the public). However, he identified a set of circumstances under which 'committing to concealing a certain kind of information can make the principal better off', therefore suggesting that full transparency is not always beneficial.

Meade and Stasavage (2008) used a theoretical model to explore career concerns and the incentive for central bankers to be fully transparent when their deliberation is held in private versus in public. They argue that where statements made by committee members during deliberations are likely to be made public, there is an incentive for central bankers to hold back information when they are unsure about the accuracy of their signals. Their work concludes, therefore, that the decision by the FOMC to start releasing transcripts from committee deliberations in 1993 altered incentives for dissent and may have reduced incentives for individual committee members to be totally transparent about their personal views.

Notwithstanding these limits to transparency, what is also clear in the literature is that central banks have generally not reached this optimal limit argued by the aforementioned scholars, i.e. no central bank so far has been perceived to be overly transparent. Indeed, some move towards more transparency according to one measure of transparency has been found to be accompanied by reduced transparency using another measure in some studies. For instance, using the post-1993 period at the Federal Reserve where FOMC transcripts were required to be published as a means of improving transparency, Hansen et al. (2014) found that such increased transparency reduced the amount of deliberation by committee members and subsequently reduced the number of statements released by the FOMC. Nonetheless, the overall trend across central banks is of increased transparency. Horvath and Vasco (2016) constructed a comprehensive index for transparency which included 110 countries between 2000 and 2011, and found evidence of increased transparency across all countries. Furthermore, they found evidence that the more developed countries exhibited more transparency, as could reasonably be expected, and that financial stability episodes such as high financial stress had a negative effect on transparency. These results are similar to the earlier works of Dincer and Eichengreen (2007) who had also found increased transparency in central banks since the late 1990s as well as more transparency in countries with developed political and financial systems.

Similar to the issue of optimum transparency is the literature on the role that transparency plays in inflation expectations. Levin et al. (2004), using survey results collected from market forecasters, argue that for inflation-targeting central banks, transparent communication plays a vital role in adjusting inflation expectations of the private sector. Similar to their research, van der Cruijsen and Demertzis (2007) investigated the link between inflation and inflation expectations using the model developed by Levin et al. (2004) and found that transparency does improve this link. Using a Rogoff model of a conservative central bank, Demertzis and Hallett (2007) explored the effect of economic and political transparency on the inflation gap and output gap and found that a lack of transparency does not alter the average inflation or output performance of an economy although the stability of the economy is impacted through increased inflation variability and output volatility. In line with the above studies, Sibert (2006) found corroborating evidence that increased transparency lowers the variance of planned inflation, however her work also provided a counter-argument that increased transparency can ‘worsen the public’s ability to infer the central bank’s private information’. She suggested that as a result of this, such increased transparency can make inflation-averse central banks significantly worse-off.

In practice, inflation-targeting central banks such as the Bank of England (BoE) have particularly focused on transparency in their communication in a bid to drive the effectiveness of their inflation-targeting policy (Geraats, 2002). The need for greater transparency has also been driven to some extent by central banks becoming more independent in terms of policy decision making, which therefore requires more accountability from them. As of the turn of the new millennium, Fry et al.’s (2000) research suggest that 74% of 94 central banks surveyed considered transparency as vital for, or a very important component of, their monetary policy framework. Indeed, through its One Bank research agenda, the BoE stresses transparency of its policy communication as one of the frontier research areas it seeks to pursue imminently (Bank of England, 2015). In 2014, having been prompted by the Treasury Select Committee, the Bank commissioned former US Fed governor Kevin Warsh to review its communications strategy and eventually acknowledged the changes put forward by Warsh’s (2014) ‘Review on Transparency Practices and Procedures’ at the Bank, and has implemented some aspects relating to improving its transparency practices through its monetary policy communication since August 2015.

2.5 Central bank transparency and the linkage between complexity and tone

Winkler (2000) highlights that for transparent actions of central banks to be fully effective, two important considerations need to be met. First, the information they put out has to be ‘processed, structured, condensed, simplified and put into context in order to become comprehensible’ (p. 8), which he suggests captures the notion of openness. He highlights that simply defining transparency of monetary policy in terms of openness is too simple to be of practical relevance. Hence, when there are frictions in communications or imperfections in processing information, openness by itself does not translate to transparency. He therefore argues that the second important element of effective transparency is clarity and suggests that the need for clarity is important because of the information processing activity required for filtering and interpreting information.

The need to explore clarity as part of transparency is further driven by the fact that policy moves by central bankers may require them to pursue strategic considerations such as purposeful distortions or encoding of messages as part of a broader game theoretic framework. There has indeed been some evidence that clarity plays a significant role in ensuring transparency. Studies such as Fracasso et al. (2003) have shown that openness and the predictability of economic decisions can be driven by clearly written communication such as inflation reports. Winkler suggests that ultimately, transparency hinges on ‘common understanding’ between the bank and its audience which is driven by clarity in communication.

It is important to highlight at this juncture that our study captures the level of complexity of the BoE’s communication using readability statistics, although we argue that complexity is an important attribute of clarity. Earlier works on the clarity of communication such as that of Klare (1976) identify that these statistics generally capture the ease of understanding or comprehension of words and sentences due to the style of writing. We therefore identify that the writing style of a communication can be distinct from issues such as context and coherence, therefore our measures of clarity simply highlight the writing style in the communication as being clearly written or otherwise.

Given that it will be difficult to specify what exactly the internal mindset of the central bank is, it may also be useful to evaluate the overall tone of external communication for signals of internal sentiments which may not be explicitly dictated in the external communication. To this effect, our work therefore seeks to evaluate the tone of central bank communication for sentiments relating mainly to optimism and uncertainty. In summary, we therefore seek to explore clarity and tone of central bank communication as a basic framework for exploring the

transparency of central bank communication. Since what constitutes a transparent policy is ambiguous, our argument is that clarity of communication is an important precondition for transparency, i.e. it is impossible to have a transparent central bank without putting out fundamentally clear and less complex information.

To begin with, an interesting perspective which is not often explored within the transparency vs clarity literature is the view of economic agents on the transparency of central banks. The idea that transparency is more important if a central bank is perceived as being clear is a fundamental premise that is often ignored in the literature. Van der Cruysen and Eijffinger (2010) attempt to address this issue by analysing data from a Dutch household survey on the perceived transparency of the ECB. They found that perceptions of transparency matter for inflation expectations and trust in the ECB and that there are weak linkages between perceived transparency from an economic agent's point of view and actual transparency. Importantly, the extent to which recipients of information perceive information to be usable is considered a fundamental precursor to transparency.

Although a number of rational expectations studies have explored inflations expectations (or perceptions) of economic agents within a monetary policy framework (see Ranyard et al. 2008 for a survey), there is little linkage between these issues and perceptions of policy transparency. To some extent, our research seeks to address some of these issues by looking into the role of clarity in the transparency of central bank communications. Our premise is that economic agents can only perceive the central bank to be transparent if they clearly understand the communication being put out and therefore any mismatch between a central bank's stance on transparency and the perceived transparency by economic agents may have implications for policy makers. Indeed, a number of useful studies have suggested the need for more work to be done on the role that clarity and other dimensions play in central bank communication. For instance, Ronaldo and Rossi (2010), having found strong evidence of the occurrence of central bank communication driving the currency, bond and stock market, warn that these results should be interpreted with caution and they propose further research on 'the content, the clarity, the length and complexity of central bank communication and its market effects' (p. 502).

Perhaps the most valid argument in favour of exploring the clarity of communications provided by central banks is the literature on the ability of economic agents to digest communications released by the central banks. The basic idea of rational inattention proposed by Sims (2003) is central to this strand of the literature. He argues that because economic agents have limited cognitive ability, central banks should publish as much detail as possible so that

market participants can pick up different pieces of information as they understand it. He further argued that how these pieces of information are picked up by individual participant does not matter as individual views will cancel each other out in the aggregate.

Using a stylised OLG model, Gaballo (2013) argues that Sims' conjecture is true as long as the economic agent does not pick up market-generated information as well (e.g. fake news). If these findings are indeed valuable and are based on the idea that human cognitive capacity is limited, the complexity of communication therefore becomes important for central bankers wishing to put out information to a broad audience. Gaballo argues that there are two main aspects involved in understanding the central bank's communication and these are the drivers of the quality of the communication. First is the limited cognitive ability of agents in understanding language and second is that the central bank itself may set out to intentionally include some degree of ambiguity in their communication. Our study argues that no matter the level of intellectual capacity of the users of central bank communication, the complexity of the communication will always be a fundamental avenue that drives usability of information put out by central banks.

On the contrary, another strand of the literature based on the arguments for bounded rationality (see Kahneman, 2003) argues for limits on the amount of unclear information put out by the central bank. These mainly argue that the central bank should limit its communication on issues which itself is not clear about, such as the evolution of the economy as these may transmit noise signals to the public. Morris and Shin (2002) proposed the idea of coordination games. They argued that given that the public overreacts to public information, any mistaken disclosure can cause great harm. Similarly, the underweighting of private information may cause worse harm if the cost of acquiring private information is costly. Therefore, central banks have to balance the need to provide clear information with the need to withhold private information where necessary. Svensson's (2006) response to this idea was for the central bank to put out as much information as possible but increase its signal-to-noise ratio (i.e. clarity) to the extent that this is higher (clearer) than information possessed by private agents.

A final but relatively unexplored argument for observing clarity and tone within central bank communication arises from what Blinder (2004) defines as the 'cacophony problem'. He argued that when monetary policy decisions are taken by a group of people, often in a committee, rather than by an individual, there is the danger that too many dissimilar voices might confuse the public. In such a scenario, the public will look to the overall tone and clarity of the joint communication rather than trying to decipher what each member of the committee

is saying. Blinder et al. (2008) argue that if there is too much disparate communication from members of a monetary policy committee, such uncoordinated communication may lower the signal-to-noise ratio. This argument is a fundamental motivation for our approach to evaluating the overall clarity and tone of communications such as MPC minutes and inflation reports. Despite the foregoing, there is still a dearth in the literature about the role that clarity plays in transparency as well as in overall monetary policy and our study seeks to contribute to the literature in this area.

Although there is no generally accepted measure of clarity within the literature, Blinder (2009) argues that most measures of clarity used suggest that clearer communications presumably have a higher signal-to-noise ratio but his work does not quantitatively capture this. Using inflation reports from 19 inflation-targeting central banks, Fracasso et al. (2003), using three subjective measures of clarity developed by themselves, highlight that clarity of information was found to increase the quality of information provided in the inflation reports of these banks as well as the predictive information of the reports. Such increased predictive capacity of central bank communication is defined as transparency by Geraats et al. (2002). Ehrmann and Marcel Fratzscher (2009a), proposing press conferences as a clarification tool, found that press conferences by the ECB provided substantial additional information to financial markets beyond those provided by monetary policy communication. They found that press conferences on average had larger effects on asset prices than the corresponding monetary policy communication and also led to less volatility in the markets, therefore providing more signal-to-noise ratio.

Other studies have used readability statistics similar to those used in this study to capture clarity. Jansen (2011a) uses the Flesch-Kincaid Grade Level and the Flesch-Kincaid Reading Ease to compare the clarity of congressional testimonies for Greenspan and Volcker and found significant differences in clarity in their tenures as Fed chairman. Furthermore, Jansen (2011b) using the Flesch-Kincaid Grade Level highlighted that volatility in financial markets is reduced by increased clarity of the Humphrey-Hawkins testimonies by Fed chairmen. In this study, we rely on the Flesch-Kincaid Grade Level to measure the clarity of MPC minutes and inflation reports in our analyses. Details of our approach are highlighted in the methodology section of our work.

2.6 Central bank communication: empirical evidence and cross-country variation

The impact of central bank communication on the financial markets and macroeconomic environment has been widely debated with mixed results in the empirical literature. Although the notion that transparency should be good for the financial and macroeconomic environment seems logical, studies such as those by Cukierman and Meltzer (1986), Cukierman (2011), Geraats (2007) and Rhee and Turdaliev (2013) have argued that opaque regimes have benefits that outweigh transparent regimes. Cukierman and Meltzer (1986) argue that ambiguous scenarios allow central banks to use more ambiguous control procedures during periods where objectives are more uncertain. Their seminal work is largely based on the premise that opacity enhances monetary policy because a fully transparent communication policy cannot lead to surprises. They highlighted that their results present an explanation for the Fed's perceived ambiguity in the years leading up to their research.

Using the transparency index created by Geraats (2002), Christopher and Meade (2008) found that greater transparency in the form of frequent release of forecast increases the use of public information by the private sector. Their study compares central bank independence and central bank transparency and they found that independence and transparency have increased across both emerging and developed markets. Importantly, they argue that the demand for transparency is significantly driven by market participants in countries with a developed financial market. Previous work on the transparency of the ECB by Cukierman (2011) also seems to support this notion.

Geraats (2007) argues that the optimal communication strategy for central banks is to provide transparency on the inflation target but introduce some ambiguity in the communication related to the markets about the output targets and supply shocks. On the benefits of ambiguity to the financial markets, they argue that creating a perception of ambiguity has the potential to mute market volatility since markets respond more to signals that are perceived to be clear. In fact, this argument lends weight to the famous quote by Alan Greenspan about mumbling with great incoherence. However, the benefits of increased transparency in enhancing central bank credibility, flexibility and reputation is well documented within the literature (see Eijffinger et al. 2006 for a review)

In terms of communication, the long-term goal of central banks is long-term predictability, a goal which underscores that members of the public develop a genuine understanding of the manner in which a central bank thinks and operates. As Blinder et al. (2008) highlight, this means that all the relevant news for financial markets will be obtained from the economy and not the central bank as the central bank's reaction function is so well

understood. Indeed, some studies, such as that of Bernoth and Hagen (2004), have shown that the predictability of interest rate decisions by the major central banks have improved significantly in the few years leading on to their research. In analysing the predictability of short-term money market rates within the European Monetary Union (EMU) using the three-month Euribor Futures rate, they found that euro money markets were able to predict short-term rates well. Their report thus suggests that ECB communication of monetary policy has worked significantly well since the formulation of the EMU. It is important to note that as with their work, most studies have relied on short-term predictability rather than long-term and have used financial markets responses as a gauge.

Most of the other literature on the effects of central bank communication on financial markets is captured through the monetary policy impact on financial assets and, in a somewhat related manner, interest rates. The seminal works of Kohn and Sack (2003), which show significant impacts of communication on short- to medium-term interest rates in the US as well as the work of Reeves and Sawicki (2007) showing the same for the UK, are discussed elsewhere in this literature review (see also Ehrmann and Fratzscher, 2007(b) and Musard-Gies, 2006). The main financial markets often considered are the foreign exchange markets, the bond markets and the stock markets.

Fratzscher (2006) argued that central bank communications on exchange rates have a significant contemporaneous effect on exchange rates. They found that communication reduces exchange rate volatility and uncertainty up to a six-month horizon and in the direction anticipated by the central banks. Interestingly, they also found that actual policy intervention tends to raise volatility and uncertainty, thereby suggesting that communication is a more superior policy over the medium term. Using the case of the Bank of Japan, Gnabo et al. (2009) also found that speaking to the markets using statements does reduce some ambiguity in the foreign exchange markets. However, they pointed out that oral intervention did have the potential to increase volatility in the exchange rate market. Using five-minute returns for spot euro-dollar, euro-sterling and euro-yen exchange rates, Evans and Speight (2010), found that interest rate decisions announced by the ECB had significant effects on all three rates.

Similarly, using high-frequency intraday data for five countries, Rosa (2011) found that the surprise component of the Fed's communication amounted for most of the explainable variation in the exchange rate's response to monetary policy. They also found that volatility from communications was short-lived and was absorbed by the foreign exchange market within 30 to 40 minutes of release. With specific reference to the Bank of England's communication, there have been limited studies looking into this. Reeves and Sawicki (2007) explored the

BoE's MPC minutes and inflation reports and found that these increased the variance of asset prices with the effect on the short sterling futures being most pronounced.

A number of other studies that have focused on emerging markets have also found that central bank communication has a calming effect on exchange rate volatility (e.g. see Fišer and Horvath, 2010 and Goyal and Arora, 2012). There has also been evidence of US monetary policy communication impacting financial markets beyond the US. Hayo et al. (2009), using an E-GARCH model that explored the effects of the FOMC's communication on European and Pacific markets, found that the Fed's communication significantly impacted equity markets in these regions. Particularly, they found that Pacific markets reacted to US monetary policy communication more than European markets did. It is important to note that some other studies such as Conover et al. (1999) and Kim (2003) have also considered the effects of US macroeconomic policy news on financial markets across the world; however, these did not evaluate FOMC communication as a policy tool and therefore are out of the scope of our research.

On the effects of central bank communication on the bond markets, de Goeij and Marquering (2006) analyse the effects of monetary policy announcements on the volatility of the one-, three-, five- and ten-year US Treasury bond returns and found that announcement shocks have a significant impact on the dynamics of bond market volatility. Particularly, in line with the expectations theory, they found that monetary policy announcements seem to affect short-term bond volatility. Using a more theoretical approach by modelling a high-frequency policy rule based on yield curve information and an arbitrage-free bond market, Piazzesi (2005) argues that communications from the FOMC improve the fit of the yield curve and present vital seasonalities around FOMC meetings. Ronaldo and Rossi (2010) use communications from the Swiss National Bank, encompassing monetary policy announcements, speeches and interviews, to analyse high-frequency movements in the Swiss currency, bonds and stock exchange markets. Similar to a number of studies such as those of Gurkaynak et al. (2005) and Kohn and Sack (2003), they also found that the bond markets are the most responsive to the central bank communications about monetary policy. These consensus results are not without reason as macroeconomic news stories are generally the main price drivers in the bond markets, as firm-specific news is in the stock markets.

In relation to the stock markets, there is a rich literature on the effects of central bank communication and most of this focuses on the role of monetary policy surprises on the stock market. For the purposes of this research, however, we will focus more on the studies that uniquely identify communication as an alternative policy tool. Earlier studies, such as

Gurkaynak et al. (2005), identify the need to separate a traditional federal funds rate approach from a ‘communication about the future path of policy’ approach. Using a high-frequency event study analysis, they tested whether the federal funds rate in itself adequately captures the effect of monetary policy on asset prices and found that communication is also required in capturing the full effects of monetary policy on asset prices. Due to the increasing policy shift towards communications by central banks, their study further justifies the need to explore the role communication plays in understanding the effects of monetary policy on asset prices.

More recent research done by Papadamou et al. (2014) argues that central bank communications seem to calm markets down by reducing volatility. Using a comprehensive database from 40 countries, they found that countries with a high level of transparency have less volatility in their stock markets and vice versa. As an example, Romania, Russia and Ukraine were found to have some of the least transparent central banks accompanied by higher volatility whilst the UK, Canada and New Zealand were the opposite in both transparency and volatility.

Finally, among studies on the effects of transparency on macroeconomic variables, Chortareas et al. (2002) indicate that the disclosure of inflation forecasts reduces inflation, but is not necessarily associated with higher output volatility. Demertzis and Hallet (2007) found that greater transparency reduces inflation volatility but has a less clear effect on output volatility and no effects on the average level of inflation and output. The analysis of Dincer and Eichengreen (2007) suggests broadly that increased transparency driven by more communication has the tendency to reduce output variables and inflation persistence. Using the Flesch-Kincaid Grade Level, Bulir et al. (2013a) assessed the clarity of seven central banks’ communications from inflation reports against inflation outlook. Their study found no significant patterns across all central banks but they did find that in three of the cases, the financial crisis reduced the clarity of the communication.

2.7 Capturing central bank communication

Following on from the above, another significant issue is how to accurately capture central bank communication in a manner that allows researchers to empirically evaluate it. As Lucca and Trebbi (2009) identify, although there has been a significant theoretical contribution to the analysis of central bank communication, there remains a considerable gap in the literature regarding empirical research, partly because of the difficulties involved in quantitatively measuring central bank communication. There is no generally accepted means of capturing central bank communication as data and studies within the field have used a variety of methods

ranging from simple to very complex techniques. For the purposes of this study, we identify two broad –approaches: studies that have simply attempted to count the number of communications released by central banks, and studies that have carried out content analysis or textual mining of communication text.

Given that there is a perceived linkage between transparency and the amount of communication a central bank releases, it makes sense that certain studies will look to the quantity of communication released by central banks in their analysis of transparency. Studies such as those of Kohn and Sack (2003) and Reeves and Sawicki (2007) are examples of research that simply relies on quantifying the number of communication documents released as a measure of central bank communication. Although the direction of such literature is usually only aimed at expressing the relationship between increased numbers of central bank communications and their impacts on financial markets and/or policy, the limitations of such measures are obvious. For instance, both studies above detected that an increase in central bank communication increased financial market volatility; however, it is not clear from such findings if the desired direction of the monetary policy communication was indeed achieved by the communication.

Other studies that do attempt to explore the contents of the central bank communications rely on subjective ratings of texts by researchers, which, according to Blinder et al. (2008) is similar to a narrative approach to modelling policy making (see e.g. Ehrmann and Fratzscher 2007a; Ferrero and Secchi, 2007). Bholat et al. (2015) provide a detailed narrative of the various approaches to textual mining and broadly identify the kinds of textual mining techniques that are relevant to the central banking literature. The key methods highlighted include Boolean techniques, which use basic search functionalities to quantify text; the dictionary technique, which uses frequency of keywords; text weighting techniques, which advance dictionary methods by attributing varying weights to different words; vector space models, which quantify text using similarity of topics, and finally latent variable models which use algorithms to associate documents to certain latent variables.

Although dictionary methods are quite common in the field of finance and accounting, (see Loughran and McDonald, 2016 for a survey), their use in the central banking literature is relatively limited. Studies within the central banking field tend to use machine learning latent variable techniques. For instance, Lucca and Trebbi (2009) used two classes of automated semantic algorithms using Google Semantic Orientation score and the Factiva semantic orientation score, both measuring communication by computing scores from FOMC statements. Ranaldo and Rossi (2010) also used Factiva scores to measure central bank

communication along the same lines while Schonhardt-Bailey (2013) used the Alceste software to capture central bank communication. All these approaches generally seek to explore attributable traits in communication that will help researchers classify and quantify text.

For capturing the tone of central bank communication, our study uses Diction®, which is a computerised textual analysis software that uses a 10,000-word corpus to quantify text into five master variables. The software fits within the definition of machine learning latent variable techniques described above. Although widely used in the finance and accounting literature, Diction is now increasingly being used in central banking research. For instance, studies such as Graddy and Beauchamp (2014) and Born et al. (2012) have used Diction to quantify tone such as ‘optimism’ scores of central bank communications whilst assessing the effects of central bank communication on financial markets. A more detailed review of the Diction software is provided in other sections of this research.

Given that we also seek to explore the clarity of communication, we borrowed a set of tools from computational linguistics to measure clarity in central bank communication. Although measuring the clarity of central bank communication is relatively new within the central bank communication literature, readability statistics have generally been found to contain useful signals for readers interested in assessing public documents. Using Flesch-Kincaid Reading Ease scores for a group of 120 annual reports from Hong Kong companies, Courtis (1998) found lower readability is often associated with bad news and high press coverage. Using the Fog index on a sample of over 50,000 firm years, Li (2008) found that companies that have lower persistent earnings had more complex annual reports whilst the annual reports of companies with higher persistent earnings were easier to read. Using the Fog index, Biddle et al. (2009) found that firms with better clarity in their financial reporting deviate less from predicted investment levels and show less sensitivity to macroeconomic conditions, a notion which this research seems to share to an extent.

Some other similar studies, such as De Franco et al. (2013), have explored the informational quality of clearly readable financial reports. Using an extensive database of 356,463 sell-side analyst reports, they found that clearer financial reports were associated with a significantly higher trading volume around a three-day window. The analyses within these studies are similar to those we propose in our study of central bank communication, and these present us with a credible background to our analysis of central bank communication.

2.8 Optimism and uncertainty in central bank communication

If we assume that central banks are truly transparent and would openly communicate their policy intentions through the various communication channels, then assessing policy communication would be the most effective way of determining central banks' intentions. However, in assessing policy communication, relatively few studies have focused on the contents of communications while others focus on the occurrence of communication. In this research, we argue that complexity of communication and the tone of communication are important precursors to transparency and we therefore seek to evaluate these as a basic framework for exploring the sentiments expressed via central bank communications. If expectations are to be driven by the way in which central banks perceive developments in the economy, there is indeed the need to explore the sentiments captured by the public via central bank communication. For instance, there is a belief in the financial press that when central banks are optimistic about the state of the economy, there may be a rate rise on the horizon, as has been demonstrated by responses to some of the comments by central bank governors lately. Therefore, understanding the dynamics of optimism in response to the macroeconomic environment may be important.

This idea is also important where central banks, such as the BoE, communicate via a policy committee that may be subject to the 'cacophony problem' as identified by Blinder et al. (2008). Therefore, individual voices may not give a clear picture of the direction of communication, but the tone of the collective communication can be captured. This study therefore seeks to use the novel techniques of computational linguistics to measure dimensions of optimism and uncertainty in central bank communications in a bid to parse the sentiments of central banks.

Optimism in central bank communication is an integral part of the central bank transparency literature. According to van der Crujsen and Eiffenger (2010), perceptions of the transparency of central banks are highly influenced by individual characters, certain psychological processes and the fact that market participants have imperfect knowledge. They argue that the extent to which markets are optimistic matters in the formation of transparency expectations. It is frequently argued in central bank communication literature that financial markets look up to the central banks for information because they believe that central banks have superior information about the state of the economy. Studies such as Effinger and Tesfaselassie (2007) point out that central bank forecasts consistently outperform those of the private sector whilst Romer and Romer (2000) found that the Federal Reserve does indeed possess private information about the future state of the economy that markets are not aware

of. The implication is that market participants will seek to observe attributes in central bank communication that will then be factored into their own decision making.

One of the key attributes that market participants look out for in trying to decipher central bank communications, and one which has been very popular with researchers, is the level of optimism in the communications. Whilst researching components that feed into central banks' perceived transparency, van der Cruijssen and Eiffenger (2010), using their constructed transparency knowledge index, found that respondents who perceived the central banks to be more optimistic also perceived them to be more transparent; which would imply that such central banks are more effective, according to central bank transparency literature.

Other studies that try to evaluate the effects of central banks' communication on financial markets often evaluate these by measuring optimism in central bank communications. An example of such a study is Born et al. (2014), who found that financial markets respond to central bank communications through an analysis of optimism or otherwise in central bank communication. Their study uses Diction, the same computerised software used in this study, to measure optimism in Financial Stability Reports (FSRs) and interviews released by seven central banks. They then subsequently evaluated the effect of optimism on financial markets.

Furthermore, an alternative body of literature exists along the lines of behavioural finance, which argues that participants in financial markets are not always rational but also seek clues from their surroundings when making financial decisions. Wang (2001) argues that non-rational investors would often be influenced by investor sentiments that stem from how optimistic they are about the financial market and information coming through. As central banks are an essential source of information for financial market participants, it would be expected that market participants would therefore be looking to decipher optimism or pessimism from central bank communications. In a zero low bound environment in particular, the financial press often seeks to parse the level of optimism of the central bank as a measure of the likelihood of an interest rate rise. These rationales are motivation for analysing perceived optimism in central bank communication as one of our observed dimensions of communication.

Uncertainty in macroeconomic policy literature, on the other hand, is a very ambiguous concept and has been captured in various ways over the past decades. Friedman (1968), in his work on the role of monetary policy, was one of the first authors to highlight the immense role uncertainty plays in the setting of monetary policies. Bernanke (1980) argued that uncertainty is central to economic policy because it is seen to retard investments, independently of the common considerations of risks or expected returns. Beyond these initial papers, several studies, such as Rodrik (1991), have sought to highlight various issues relating to measuring

uncertainty as well as its impact on the various facets of the economy. Similar to Gruner (2002), we make the distinction here between uncertainty coming from the central bank regarding its objectives and inflation uncertainty, which is brought about by a combination of actions by macroeconomic players. To this end, we focus our analysis on capturing uncertainty from the BoE's communication of its objectives.

Blinder et al. (2008) highlight that uncertainty is a vital part of central bank communication that has received scant attention in the past. They argue that uncertainty can arise in various forms; first is the scenario where different members of monetary policy committees say different things. Along these lines, some studies such as Ehrmann and Fratzscher (2007c) have found that inconsistent voices within monetary policy communication have led to less predictability of policy decisions within short- and medium-term horizons. Second and similar to this idea is the argument that disparate voting records may signal uncertainty of a central bank's monetary policy direction. Gerlach-Kristen (2004) found that voting records of the BoE's MPC members helped predict future monetary policy changes and that minority votes carried much more information than did votes in favour of the majority.

Although no objective measure of uncertainty exists, many parts of the finance-related literature associate uncertainty with conditional volatility, mainly of observable outputs. Juado et al. (2014) identify that the main measures of uncertainty have relied on proxies or indicators such as: implied or realised volatility of stock market returns; the cross-sectional dispersal of firm profits, stock returns or productivity; the cross-sectional dispersal of subjective (survey-based) forecasts, or the appearance of specific 'uncertainty-related' key words in news publications. The limitations in the use of some of the above measures are often intuitive and some have been argued to be an inconsistent measure of uncertainty based on research findings. For instance, Juado et al. (2014) argue that implied volatility of stock market returns can change over time even if there is no change in uncertainty about economic fundamentals.

Of all the measures, survey-based approaches and fan charts have become very popular over the past few years and one can argue that the use of surveys that draw expectations about future economic outcomes in the form of subjective probability distributions (called density forecasts) may provide more substantial measures of uncertainty. Such surveys as the Survey of Professional Forecasters (SPF) in the US and the Bank of England's Survey of External Forecasters (SEF) are widely used as a measure of uncertainty (e.g. see Lahiri and Sheng; Boero et al. 2008; Giodarni and Soderlind, 2002). Although such density functions are often perceived as an accurate measure of uncertainty, studies such as Giodarni and Soderlind (2002) have questioned the accuracy of such methods. They identified the three main methodologies

in this approach as disagreement among forecasters, average individual forecast error variance (or standard deviation) and the variance of the SPF's histogram (similar to the now SEF approach). Using a multivariate normal distribution function, they found that disagreement is a better proxy of uncertainty and that forecasters generally underestimate uncertainty.

Studies such as Lahiri and Sheng (2008) also find evidence to support the superiority of disagreement in SPF forecasts as a measure of uncertainty but extend the argument by stating that in addition to disagreement, uncertainty also contains a component of the variance of future aggregate shocks that accumulate over the horizons. They further proposed the use of GARCH type models to estimate the ex-ante variability of aggregate shocks as a component of aggregate uncertainty.

In much earlier literature, where standard forecast data and the internet were unavailable, econometric approaches were most often used to capture uncertainty and the proxies used in these methodologies are, of course, as diverse as the methodologies themselves. Earlier works by Bernanke (1980) define uncertainty with respect to a delay in making investment decisions and capture uncertainty using a vector model that gives the excess of net return over the value of 'waiting to invest' in various information states. He argued that the reduction in the likelihood of investment in a period is what is meant by 'investor uncertainty' and this depends to a large extent on the expectations of both very good and bad news.

Another popular body of economic literature that attempts to measure uncertainty does so in relation to inflation, output and unemployment. Several of these studies use the well-documented methodologies that rely on the rational expectations paradigm and the expectations-augmented Philips curve and then focus on modelling the uncertainty surrounding the expectations. Bomberger (1996) summarises that the measure of uncertainty in these approaches is often based on ARCH models which are a natural extension of the rational expectations models. He stated that the estimated conditional variance at each date is assumed to reflect the uncertainty of a representative forecaster. Similarly, some studies have attempted to measure uncertainty as they relate to units within macroeconomic policy. For instance, Giodarni and Soderlind (2002) evaluated uncertainty within macroeconomic policy with specific emphasis on inflation and real GDP growth uncertainty. Boero et al. (2008) also identified that density functions are sometimes used at a micro level requiring a large-scale sample survey of households and firms; however, as this study is concerned with uncertainty at the macro level, we discount this approach.

Although capturing uncertainty using the foregoing empirical econometric time series analysis may present robust measures for uncertainty, there are certain limitations that

potentially make the use of alternative methods such as those proposed in this study superior. For instance, time series methods are significantly constrained when there is a substantial structural break within the series which will thus be a major constraint given the occurrences during the recent financial crises. In a different example, Giordani and Soderlind (2003) argued that the presence of target setting, such as inflation targets, creates a structural break within time series used for measuring uncertainty and thus renders time series models an inadequate measure in such an instance. There are also issues such as the disagreement in the literature as to which time series model best captures uncertainty and the need for actual economic agents to be involved in capturing what they perceive to be uncertainty.

With increased openness in policy makers' communication about the course of their future actions over the past few years, a new literature immersed in measuring policy uncertainty through communication channels has evolved. These studies often use dictionary methods that evaluate central bank communications and attempt to highlight frequencies of uncertainty-related words or phrases. One prominent example of such studies is the work of Baker et al. (2013) which developed a new measure of economic policy uncertainty (EPU), known as the EPU index, and was based on three components, one of which was the frequency of newspaper references to economic policy uncertainty. The other two components focused on disagreement on forecasts of future inflation and government purchases, and the number of US federal tax code provisions set to expire.

This first component of the EPU is similar to the approach being proposed to measure uncertainty in this study; however, some of the limitations in using the EPU index are projected to be transcended. First, the EPU component that tries to measure uncertainty from newspapers uses both automated and subjective measures that may limit the capture of uncertainty. The process involves searching for a limited corpus of words which are perceived to relate to uncertainty in a number of national newspapers and then drawing up an index based on the frequency of search results. The limitation is obvious as the corpus, which is often subjectively selected, will most likely be unable to capture all statements relating to uncertainty. This is true of most dictionary type approaches both in terms of the ability to capture the scope and also the semantics of statements relating to policy uncertainty. Our study attempts to address this in a specific way, by focusing only on macroeconomic policy statements released by central banks and aimed at the public. This study also takes this methodology further by using Diction, a computerised analysis that not only recognises frequency of associated words but also uses a database consisting of 50,000 previously analysed texts to detect tone and semantics within text.

2.9 Conclusion

This chapter sought to review the extant literature on the various aspects of central bank communication that are relevant to our study. In the first instance the chapter provides a brief introduction to central bank communication by exploring how the literature on central bank communication has evolved from the basic tenets of traditional macroeconomic policy using conventional policy tools such as interest rates to more modern inflation targeting-regimes that focus heavily on communication. Given that the focus of this study is on the Bank of England and also given the growing relevance of inflation targeting at the Bank, the chapter then goes on to detail the evolution of the Bank of England through its inception to its independence. Following on from this, the chapter goes on to explore the literature on central bank communication as a policy tool and the importance of evaluating central bank communication which our work seeks to carry out. In understanding the importance of central bank communication, how communication reaches its intended users should be also considered and therefore the literature on the mechanisms via which central bank communication can be transmitted by intermediaries was reviewed.

Integral to our core research question is the role that complexity and tone play in the transparency of central bank communication, therefore this chapter goes on review the literature on central bank transparency including empirical, theoretical and cross-country evidence on central bank transparency. A brief review of the existing methods of capturing central bank communication is included; however, these are explored in more detail in chapter three below. Finally, the chapter reviews existing literature that helps shed some more light on the linkage between transparency and the clarity and tone of communication whilst also individually exploring the literature around these dimensions of communication.

CHAPTER THREE

3.0 DATA ON CLARITY AND TONE – READABILITY STATISTICS AND THE DICTION SOFTWARE

3.1 Introduction

This chapter seeks to explain the derivation of the data used in our study particularly those that relate to our measures of clarity and tone. Given that these measures are derived using formulaic approaches which may not necessarily capture the exact spirit of the communication made, it is important to highlight the potential weaknesses of these methods of quantifying communication. First, we will highlight the method used in deriving the Flesch-Kincaid score, which is the preferred measure of complexity used in evaluating central bank communication within our work and in the literature. We then go on to compare this with other measures of clarity for robustness. Secondly, we will detail the process of quantifying the tone of communication by exploring the Diction software in some detail. Finally, this section will look to highlight the procedure used in the processing of the text used in our various analyses.

3.1.1 Quantifying the complexity of central bank communication: readability statistics

The need to explore clarity of communication is a relatively new concept within the central banking literature, hence very limited studies to date have explored this concept in detail. The main question is often how to define clarity of communication within the central banking context and some of the various attempts to do so are described in our literature review above. One of the earlier studies that assessed the clarity of central bank communication was the work of Fracasso et al. (2003), which used a survey of central bankers to assess the clarity of individual central banks' communication on a scale of 1 to 10. The obvious limitation of this approach is that it is subjective and the level of clarity would thus be determined by the intellectual capabilities of the sample surveyed and not by an objective measure, although one could argue that this is a useful approach if the right sample population was surveyed. Subsequent works that assess the clarity of central bank communications, such as Jansen (2011a) and Bulir et al. (2013), have relied on more objective measures of text complexity that use readability statistics. Similar measures of complexity using readability scores have been widely used in other subject areas such as the complexity of financial statements in accounting (Clatworthy and Jones, 2001), clarity of medical information brochures (Freda 2005) and in educational research related to student progress (Betts et al. 2009), to mention a few.

In simple terms, readability is defined as the characteristics of a corpus of texts that make it easier to read than others. It is important to stress that the level of clarity derived from the BoE's communication in our study mainly highlights the writing style in the communication in terms of whether it is clearly written or otherwise. Klare (1976) defines readability as captured by readability statistics as 'the ease of understanding or comprehension due to the style of writing'. These definitions clearly highlight that writing style can be distinct from issues such as context and coherence. Furthermore, as highlighted by Hargis et al. (1998), the 'ease of reading words and sentences', as calculated by readability statistics, is in a greater sense merely an attribute of clarity and does not wholly imply clarity. To this end, our use of readability statistics as a yardstick of clarity is limited to attributes such as complexity, writing style and structure of communication.

To better understand how readability scores can help capture a text's complexity, consider the classic example in table 3.1 below by Duffy and Kabane (1981) of two texts, one which has been derived from the other in a bid to adapt it to a lower readability score (i.e. less complex text).

Table 3.1: Comparison of sample texts with varying degrees of readability (Duffy and Kabance, 1981)

Sample–A - Flesch-Kincaid Score: 11	Sample–B - Flesch-Kincaid Score: 5
<p>The night was cloudy, and a drizzling rain, which fell without intermission, added to the obscurity. Steadily, and as noiselessly as possible, the Spaniards made their way along the main street, which had so lately resounded to the tumult of battle. All was now hushed in silence; they were only reminded of the past by the occasional presence of some solitary corpse, or a dark heap of the slain, which too plainly told where the strife had been the hottest. As they passed along the lanes and alleys which opened into the great street, they easily fancied they discerned the shadowy forms of their foe lurking in ambush, ready to spring upon them. But it was only fancy; the city slept undisturbed even by the prolonged echoes of the tramp of the horses, and the hoarse rumbling of the artillery and baggage trains. At length, a lighter space beyond the dusky line of buildings showed the van of the army that it was emerging on an open causeway. They might well have congratulated themselves on having thus escaped the dangers of an assault in the city itself, and that a brief time would place them in comparative safety on the opposite shore.</p>	<p>The night was cloudy. A sprinkling rain added to the darkness. It fell without a break. The Spaniards made their way along the main street. They moved without stopping and with as little noise as possible. The street had so recently roared to the noise of battle. All was now hushed in silence. The presence of a single dead body reminded them of the past. A dark heap of the slain also reminded them. Clearly, the battle had been worse there. They passed along the lanes and alleys opening into the great street. They easily fancied the shadows of their enemy lying in wait. The enemy looked ready to spring upon them. But it was only fancy. The city slept without being bothered by the rough rumbling of the cannons and baggage trains. Even the constant sound of the tramp of horses did not bother the city. At length, there was a bright space beyond the dark line of the buildings. This informed the army look-out of their coming out onto the open highway. They might well have rejoiced. They had thus escaped the dangers of an attack in the city itself. A brief time would place them in greater safety on the opposite shore.</p>

As can be observed, sample B, in a bid to improve the clarity of sample A, uses relatively shorter words and sentences which then makes it easier to read for individuals with

lower reading capabilities. This comparison shows how reducing word length and sentences can help improve the clarity of a text and highlights what readability scores aim to capture.

It should be highlighted that when it comes to readability of central bank communications, individuals that should benefit from central bank communications (e.g. market analysts) are expected to be highly cognitive and as such should not be affected significantly by the readability of published communication. There is nonetheless an argument for evaluating the readability of texts irrespective of the intellectual capacity of the reader. This argument is in line with the debate in the literature as to whether prior knowledge, interest and retention matter when evaluating readability scores. The works of Klare et al. (1985) addressed this through an experiment with 989 US Airforce enlistees that simplified the writing style of documents (i.e. lower Flesh Kincaid Scores) but retained the technical elements and ensured the contents also remained the same. They found evidence that more readable versions resulted in greater and more complete retention, greater amount of reading covered in limited time and greater acceptance of the material. The evidence above therefore suggests that even with prior knowledge and higher cognitive abilities, more statistically readable versions of central bank communication provides clearer information for market participants.

For central bank communication, readability scores are expected to be higher (i.e. more complex) than the example in table 3.1 above. Indeed, the lowest readability scores of most of the communications explored in our study are in the region of 11 years of formal education and the average is about 14 years of formal education. Consider the example in table 3.2 below of the lowest and the highest readability scores from the decision making section of a sample of MPC minutes.

Table 3.2: Comparison of sample MPC decision texts with varying degrees of readability

Scenario A – Flesch-Kincaid Grade Level: 11.1	Scenario B – Flesch-Kincaid Grade Level: 17.8
<p>The Committee considered the arguments for keeping the repo rate unchanged at 4.75%, to which different members gave different weights. The August Inflation Report central projection, based on the market yield curve, had been for CPI inflation to remain below the target for the immediate future, picking up steadily to meet the target around the two-year point. The 25 basis points increase in the repo rate in August reflected a movement at least as fast as that implied by the market rate curve on which the August projections had been based and the news about economic activity was, on balance, slightly weaker on the month. Medium-term inflation expectations appeared to remain well anchored to the target. So there was no case for a further rise in rates at this meeting.</p> <p>Some members also considered arguments for raising the repo rate by 25 basis points. The economy was, most probably, set to continue to grow at or above trend, and so to put gathering pressures on supply with little or no remaining spare capacity. Inflationary pressures would have been increased by a lower exchange rate and a shift down in the money market yield curve. If the lower level of market yields persisted, this might rekindle unwelcome strength in the household sector. Taken as a whole, the Committee did not find these arguments sufficient to justify a rise in the repo rate.</p> <p>September 2004</p>	<p>In the current exceptional circumstances, the Committee agreed that explicit forward guidance should be adopted. It provided a way to make the existing monetary stimulus more effective by conditioning its expectations of the future path of Bank Rate on a better understanding of the Committee’s reaction function, and thereby should reduce the risk of an unwarranted rise in market interest rates that prematurely tightened financial conditions. All members agreed that, while it was in place, forward guidance should provide the framework and context for future monetary policy discussions.</p> <p>Most members continued to believe that further monetary stimulus in the form of asset purchases was not appropriate at the current juncture; and that the onus on monetary policy was to reinforce the recovery by ensuring that stimulus was not withdrawn prematurely. These members did not rule out more asset purchases should they judge that more stimulus was subsequently required, but there remained a range of views as to the benefits of further asset purchases relative to their potential costs in terms of complicating the transition to a more normal monetary policy stance at some point in the future. For other members, the case for further monetary stimulus remained as compelling as in July. But for them, there was merit in first supporting the implementation of forward guidance and waiting to gauge its impact, in particular on financial market prices, before reconsidering an increase in the Committee’s programme of asset purchases.</p> <p>August 2013</p>

The above examples highlight two different scenarios, scenario A in which, although there were significant considerations for a rate change, the bank is clear about holding the rate at the current level and scenario B, in which the policy decision is relatively more ambiguous

and dependent on a number of analytical outcomes, as with most forward guidance decisions. The complexity of the situations is not only observed in the sentence above but also in the complexity of the communication in statistical terms.

Table 3.3 below compares attributes of both texts based on how long the sentences are and how many ‘bigger’ words are used in each scenario.

Table 3.3: Comparative analysis of sample text attributes

	Scenario A	Scenario B
Total number of words	234	239
Average number of words per sentence	21	30
Percent of 3+ syllables in text	15%	22%
Total # of words with 3+ syllables:	35	53
Examples of words with 3+ syllables in text (Considered ‘harder’ words)	Committee considered arguments different different Inflation projection inflation immediate steadily reflected movement projections economic activity medium inflation expectations considered arguments economy probably continue gathering remaining capacity. inflationary persisted rekindle unwelcome household Committee arguments sufficient justify	exceptional circumstances Committee explicit adopted. provided existing monetary stimulus effective conditioning expectations understanding Committee’s thereby unwarranted interest prematurely financial conditions. framework monetary policy discussions. continued monetary stimulus appropriate monetary policy recovery ensuring stimulus prematurely. stimulus subsequently benefits relative potential complicating transition monetary policy monetary

		stimulus compelling supporting implementation particular financial reconsidering Committee's programme
--	--	--

A further analysis of the texts' attributes in table 3.3 above highlights that although both scenarios use approximately the same number of words to communicate, scenario B has attributes that make it more difficult to read. Specifically, scenario B contains more words per sentence as well as more words with three or more syllables, which may make it more complex to read. It is these surface attributes of text complexity that readability scores aim to capture and details of how this is done are further described below.

3.1.2 The Flesch Reading Ease and Flesch-Kincaid Grade Level

By far the most popular measures of clarity using readability statistics are the Flesch Reading Ease score and the Flesch-Kincaid Grade Level. The Flesch Reading Ease formula was developed by Rudolf Flesch in 1948 and it predicts Reading Ease on a scale of 1 to 100 with scores around 30 implying very difficult text and scores around 70 being regarded as easy. The formula uses a combination of two main variables to help calculate a Reading Ease score, namely, the number of sentences per 100 words and number of syllables per 100 words.

The formula for the Flesch Reading Ease score is given as:

$$FR = 206.835 - (1.015 \times ASL) - (84.6 \times ASW) \quad \dots (3.1)$$

Where:

FR = Flesch Reading Ease score on a scale of 0 (difficult) to 100 (easy), with 30 = very difficult and 70 = suitable for adult audiences.

ASL = average sentence length (the number of words divided by the number of sentences).

ASW = average number of syllables per word (the number of syllables divided by the number of words).

The Flesch Reading Ease statistic became popular in the 1960s due to its deemed effectiveness in capturing literacy levels in the United States. However, some modifications

were proposed to make it easier to interpret and hence the development of the similar metric known as the Flesch-Kincaid Grade Level.

In 1976, the Flesch Reading Ease score was modified by a study commissioned by the US Navy so that a Grade Level score that allows for easy comparison is developed. The new readability score was called the Flesch-Kincaid Grade Level and was also found to provide a truer reflection of readability when used in an experiment that incorporated 531 US Navy personnel.

The Flesch-Kincaid (FK) Grade Level (GL) is calculated as:

$$GL = (.39 \times ASL) + (11.8 \times ASW) - 15.59 \quad \dots (3.2)$$

Where:

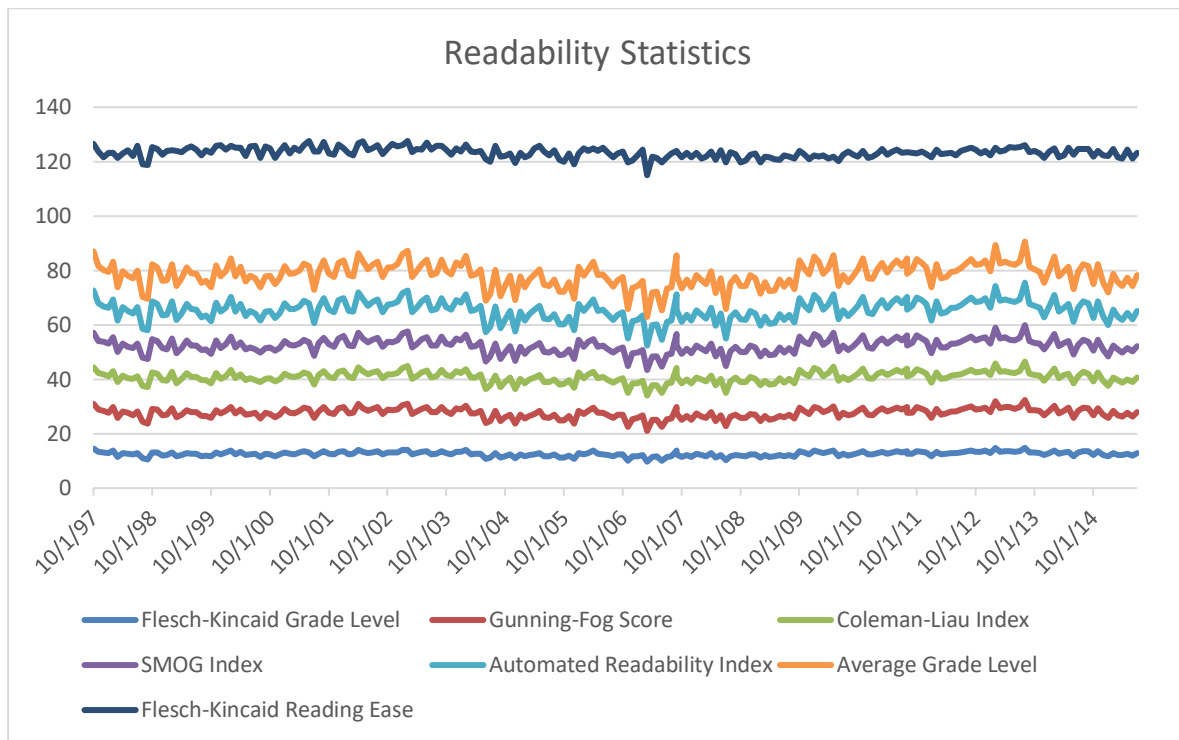
ASL = average sentence length (the number of words divided by the number of sentences).

ASW = average number of syllables per word (the total number syllables in the sample divided by the number of words).

DuBay (2004) highlights that the Flesch readability scores transformed general readability rules across different industries particularly in the print media where Rudolf Flesch and Robert Gunning helped to bring down the readability of front-page news stories (working with the Associated Press) from 16th to 11th Grade Level, where they claim it remains. He highlights that the development of the Flesch and Gunning formulae marked the end of the first 30 years of classic readability studies and brought the issue of readability to public attention. Their works also helped stimulate new studies that aided new demands for communication in plain simple language. These have also been the metrics used in foregoing research on central bank communication such as Jensen 2011 and Bulir et al. (2013).

In addition to the Flesch-Kincaid Grade Level, which we primarily used in this study, our study also calculates readability scores using other widely used readability statistics such as the Gunning Fog score, the Coleman-Liau Index, the SMOG Index and the Automated Readability Index. We use a subscription-based paid web application called 'Readable' to automatically calculate the readability scores using the formula above. We found all the readability scores to be highly correlated and thus our work only employed the most widely used Flesch-Kincaid Grade Level statistics. As the other listed readability statistics are not central to our work, we do not go into further detail about how these are calculated; however, we depict the trend from these readability statistics along with our core readability statistics used in figure 3.1 below.

Figure 3.1: Graph depicting the similar patterns of all readability scores explored



It is important to note that although the graphs show a little variation due, the slight variations present in the readability statistics are quite significant. For instance, a variation of 1 point with the Flesch-Kincaid Grade Level actually depicts that an additional year of education will be required to comprehend a text and this is indeed significant. When analysed in conjunction with other variables, these slight variations also provide further information on the effects of clarity on our variables of interest. For better clarity, the Flesch-Kincaid Grade Level is plotted on its own in the graph below with clearer variations in the data point. Figures 3.2 and 3.3 below show the variations in the FK score for our two main central bank communication documents explored – minutes of the monetary policy committee meeting and Inflation Reports. Further analysis of the variation in the trend of these are explored in the next chapter.

Figure 3.2: Graphical depiction of the Flesch-Kincaid Grade Level for MPC Minutes

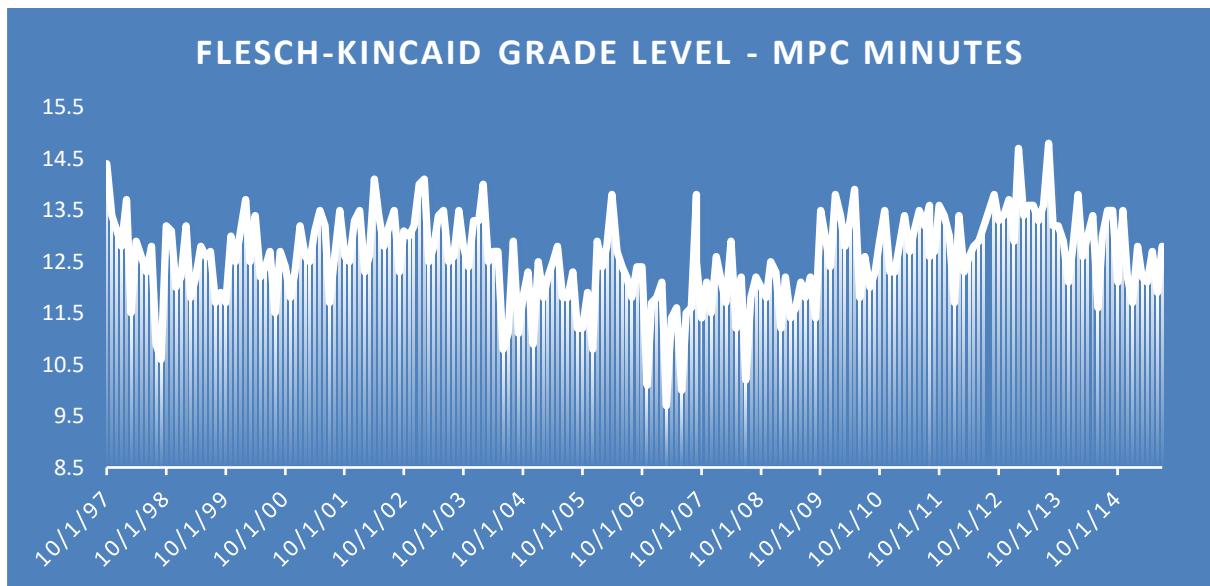
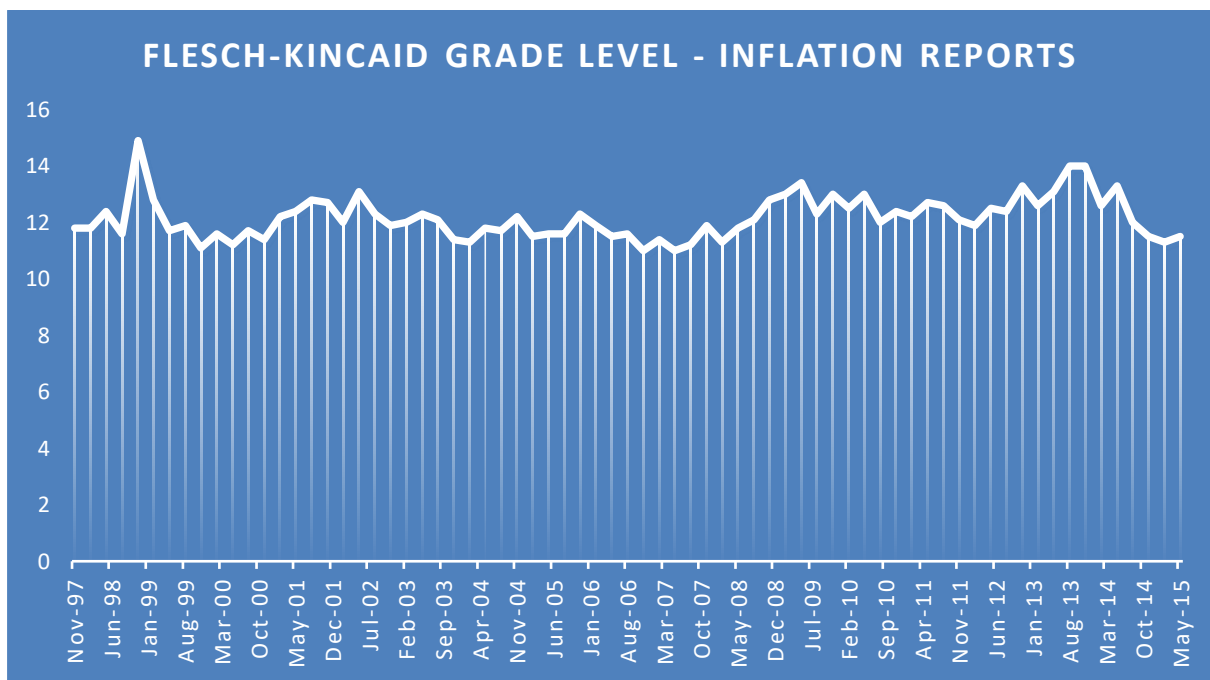


Figure 3.3: Graphical Depiction of Optimism Scores for Inflation Reports



3.1.3 Limitations of readability statistics

Given that readability statistics have been around since the 1920s, their validity has been questioned over the past decades, particularly during the period in the 1960s described as the ‘plain language movement’ which resulted in legislation around the world requiring that public and commercial documents use plain language. As a result, the demise of readability

statistics was suggested by a number of scholars (see DuBay, 2004). There were subsequently a number of tailored ‘usability’ tests introduced to capture the quality of communication; however, these gained little traction and failed to provide the objectivity that readability statistics have. Similarly, text levelling, an approach whereby a subjective analysis of reading is done via evaluating vocabulary, length, content, format and curriculum, also failed to provide consistent and objective measures of clarity. The prevailing advantage of using readability statistics as a measure of clarity lies in its objectivity and in the idea that measures of clarity are representative of the characteristics of the underlying text.

Although it is widely accepted that the main benefit of using readability statistics as a measure of clarity lies in its objective nature, there are a number of limitations to their use that should be highlighted. The most obvious limitation of readability statistics lies in the fact that the subjects reading the communication are best placed to determine what is deemed complex or unclear. Along these lines, it is often highlighted that interest in the subject matter and prior knowledge go a long way in improving cognitive ability on a subject. Given that the audience that closely monitors central bank communication is often very well educated, it is important to note that they may not necessarily find very complex language to be unclear,— although less complexity has been found to be always helpful, as highlighted above.

A further disadvantage lies in the statistical limitations of the readability formulae. Several of the readability formulae require a certain minimum number of words and/or sentences to be analysed to be able to achieve statistically significant results. For instance, the SMOG index can only calculate readability scores for texts with more than 30 sentences while the Flesch-Kincaid Reading Ease has been suggested to only estimate readability scores effectively if the text contains six or more sentences.

Despite these limitations, the use of readability software as a measure of clarity has survived the past 80 years of research in the area of effective communication. As DuBay (2004) highlights, the use of these readability statistics show the skeleton of the text and it is from this that other contexts such as content, coherence and tone can then be fleshed out. They conclude their review of the use of readability software by suggesting that any approach to effective communication that ignores the important considerations of readability statistics cannot claim to be scientific.

3.1.4 Some practical comparisons of text complexity

To highlight how readability statistics can capture the varying complexity of text, we further examine a number of text samples from MPC minutes in table 3.4 that depict this variability. We note that generally in the months where policy actions are clearer, the complexity of the text used is often lower as well. However, we notice that when policy decisions are somewhat ambiguous, as in the months where forward guidance is being used (e.g. August 2013), or where committee members have opposing views on the direction of policy (e.g. May 2006), more complex communication tends to be used.

Table 3.4: Comparison of MPC decision texts with varying degrees of readability

Less complex text	FK Score	More complex text	FK Score
<p>Although it could do little to alter the path of inflation in the near term, the Committee could, by raising Bank Rate this month, send a strong signal that it was focused on inflation and remained determined to bring it back to target in the medium term. There was a risk that medium-term inflation expectations might move significantly away from the target. If that were to happen, a more pronounced slowing in activity would be needed to bring inflation back to target.</p> <p>However, there were also a number of arguments for maintaining Bank Rate at 5.0% this month. The Committee had previously signaled that a margin of spare capacity would be required to reduce the risk of medium-term inflation expectations rising. The upside news on inflation during the month had made it necessary to have more spare capacity. But there had been downside news on economic activity during the month too, so it was possible that a higher level of Bank Rate would not be needed in order to generate that. An increase in Bank Rate in the current circumstances, when confidence was low and the financial sector fragile, could impart a downward momentum to the economy that risked a significant undershoot of inflation in the medium term. Keeping Bank Rate at 5.0% when the economy was slowing was arguably already sending a strong signal of the MPC's commitment to reducing inflation. A rate change this month would be a surprise at a time when credit and other financial markets remained fragile, and any change in rates would be better communicated alongside the Bank's August <i>Inflation Report</i>.</p> <p>July 2008</p>	11.6	<p>In the current exceptional circumstances, the Committee agreed that explicit forward guidance should be adopted. It provided a way to make the existing monetary stimulus more effective by conditioning agents' expectations of the future path of Bank Rate on a better understanding of the Committee's reaction function, and thereby should reduce the risk of an unwarranted rise in market interest rates that prematurely tightened financial conditions. All members agreed that, while it was in place, forward guidance should provide the framework and context for future monetary policy discussions.</p> <p>Most members continued to believe that further monetary stimulus in the form of asset purchases was not appropriate at the current juncture; and that the onus on monetary policy was to reinforce the recovery by ensuring that stimulus was not withdrawn prematurely. These members did not rule out more asset purchases should they judge that more stimulus was subsequently required, but there remained a range of views as to the benefits of further asset purchases relative to their potential costs in terms of complicating the transition to a more normal monetary policy stance at some point in the future. For other members, the case for further monetary stimulus remained as compelling as in July. But for them, there was merit in first supporting the implementation of forward guidance and waiting to gauge its impact, in particular on financial market prices, before reconsidering an increase in the Committee's programme of asset purchases.</p> <p>August 2013</p>	17.8

<p>The Committee considered the arguments for keeping the repo rate unchanged at 4.75%, to which different members gave different weights. The August Inflation Report central projection, based on the market yield curve, had been for CPI inflation to remain below the target for the immediate future, picking up steadily to meet the target around the two-year point. The 25 basis points increase in the repo rate in August reflected a movement at least as fast as that implied by the market rate curve on which the August projections had been based and the news about economic activity was, on balance, slightly weaker on the month. Medium-term inflation expectations appeared to remain well anchored to the target. So there was no case for a further rise in rates at this meeting.</p> <p>Some members also considered arguments for raising the repo rate by 25 basis points. The economy was, most probably, set to continue to grow at or above trend, and so to put gathering pressures on supply with little or no remaining spare capacity. Inflationary pressures would have been increased by a lower exchange rate and a shift down in the money market yield curve. If the lower level of market yields persisted, this might rekindle unwelcome strength in the household sector. Taken as a whole, the Committee did not find these arguments sufficient to justify a rise in the repo rate.</p> <p>September 2004</p>	<p>11.1 3</p>	<p>Different Committee members attached differing weights to the above arguments. Most members, however, felt that the risks to the central projection for UK GDP growth were broadly balanced in aggregate, with upside risks to the projections for investment and exports and downside risks for consumption. Equally, most members felt that the risks to the central projection for inflation were also broadly balanced. In the near term, the risks to inflation were likely to be on the upside, related to the possibility of higher commodity and energy prices. But further out, the inflation risks could well be on the downside, related to the possibility that inflation could fall back as energy prices stabilised. Some Committee members also highlighted the need to be cautious about the scope for using changes in interest rates to fine-tune small movements in inflation expectations. Finally, most members felt that the uncertainty about the degree of spare capacity in the economy meant that it was, for the moment, sensible to wait for further evidence about the likely direction of inflationary pressures.</p> <p>On balance, most members felt there was no need to stimulate demand at this time given the signs of a pickup in growth and the near-term risks to inflation from higher energy prices. Equally, there appeared to be no pressing need to tighten policy given the continued weakness of domestically generated inflation. One member felt that the balance of risks to inflation, relative to the 2% target, had shifted a little too much to the upside for comfort and that warranted an immediate increase in rates. Another member felt that a small reduction in interest rates was warranted to stimulate demand and help increase the level of domestically generated inflation back towards 2%.</p> <p>May 2006</p>	<p>14.61</p>
<p>The arguments for leaving rates at 7.50% were as follows. The slowdown in activity and demand so far was broadly in line with the Committee's earlier forecasts, resolving the earlier uncertainty about whether a turning point had been reached. The downturn also appeared so far to be somewhat more balanced than previously expected. On the other hand, the earnings data were clearly worse than expected in May, implying that the short-run nominal/real trade-off had deteriorated. That would probably continue for a while, and was reflected in the Committee's forecast. While the risks to inflation were on balance on the upside, there were downside risks. In particular the forecast of consumption growth depended in part on private sector wealth and thus on the course of the equity market, which had recently become more rather than less uncertain. And the recent striking fall in consumer and business confidence, evidenced by surveys and the Bank's regional Agents, signalled downside risks to activity and inflation. These risks might be greater than reflected in the forecast. For example, the downturn might prove sharp enough to prevent the</p>	<p>11.8</p>	<p>All Committee members agreed that the central message of the February 2014 Inflation Report guidance remained relevant: given the likely persistence of headwinds weighing on the economy, when Bank Rate did begin to rise, it was expected to do so more gradually than in previous cycles. Moreover, the persistence of those headwinds, together with the legacy of the financial crisis, meant that Bank Rate was expected to remain below average historical levels for some time to come. That guidance on the likely pace and extent of interest rate rises was an expectation, not a promise: the actual path Bank Rate would follow over the next few years was uncertain, and would depend on economic circumstances.</p> <p>For most members, the outlook for inflation described in the August Inflation Report meant that it was not necessary to change the policy stance at this meeting. In light of</p>	<p>14.93</p>

<p>forecast rise in earnings growth being passed through into prices in the short run, although that would tend to increase latent price pressures beyond the two-year horizon, since margins would probably be rebuilt at some stage. In sum, given that inflation was forecast to be close to the target in two years' time and that the outlook beyond then was highly uncertain, the Committee could sensibly wait to gather more information before concluding that policy needed to be changed.</p> <p>August 1998</p>		<p>the reduction in oil prices and appreciation of sterling over the past three months, it appeared that the increase in inflation over the following year would be more gradual than had previously been supposed. To the extent that the appreciation of sterling could be expected to weigh on inflation for a persistent period, the corresponding pickup in domestic costs necessary to return inflation to the target within three years would be greater. The data on wage growth had surprised significantly to the upside over the past quarter, though this reflected the more volatile bonus payment component. Measured productivity had also surprised significantly to the upside, leaving the growth of unit wage costs in line with the May forecast. They agreed on the importance of monitoring developments relative to the forecast in particular regarding wage growth, productivity, measures of core inflation, import prices, and the risks to the international environment.</p> <p>Some members saw upside risks to the inflation forecast, reflecting the likelihood of: stronger demand growth, buoyed by improved credit conditions and consumer confidence; a smaller degree of spare capacity than assumed in those projections, with commensurately stronger pay growth; and faster and less pronounced pass-through to consumer prices of the appreciation of sterling, such that the drag on inflation at the policy horizon from import prices would probably be less than had collectively been assumed. For one member, these risks to the medium-term inflation outlook were now, on balance, sufficiently to the upside to justify an immediate increase in Bank Rate. They increased the risk of a more significant overshoot of inflation following its return to the target. For this member, it was unlikely that much greater clarity could be achieved by waiting to see how the data evolved over the next few months, while postponing the start of the process of gradually raising Bank Rate increased the risk of having to increase it more sharply later on.</p> <p>August, 2015</p>	
--	--	--	--

3.2 Quantifying the tone of central bank communication: Diction Software

To evaluate the tone of central bank communication, we again employ textual analysis and explore the two dimensions of communication tone; namely, optimism and uncertainty. To analyse these dimensions of tone, we employ a textual analysis software called Diction which has been used extensively in the field of finance, accounting and, more recently, in economics.

To better understand the conceptual framework through which we aim to explore the tone of communication using Diction, it is important to initially evaluate some key literature on the use of this software within academia and how this has evolved over time. Subsequent sections after this will go on to explain the methodological framework used by the Diction software and the limitations of the software.

3.2.1 A brief review of the literature on Diction

Many of the earlier works done using Diction mainly focused on measuring the tone of political discourse using its linguistic tools. Of more importance to this study, however, is more recent research on the use of the software in economics, finance, and partly in accounting discourse. The idea that corporate disclosures through annual reports provide information that drives investor sentiments is central to much of the research that uses Diction for content analysis. Kearney and Liu (2014) and Li (2008) provide broad reviews of the growing literature on using content analysis within a finance and accounting context. Their reviews also argue for the importance of understanding textual sentiments in today's rapidly evolving communication landscape.

Using vocal cues from earnings conference calls with managers, Venkatachalam and Mayew (2012) found that Diction-derived sentiments from managers effectively predict future earnings two periods ahead. They propose that their findings may present useful research opportunities for exploring Federal Reserve communication and investor reactions. Davis and Tama-Sweet (2011) used Diction to explore 13,000 firm quarters of management, disclosure and analysis (MD&A) sections of annual reports and found a positive relationship between optimistic language derived by Diction within the text of MD&A and firm performance. They also found evidence that earnings releases by managers tend to be used as an alternative outlet to communicate with the markets and are often more optimistic. In contrast, using Diction to analyse a large sample of Fortune 500 companies, Patelli and Pedrini (2013) argue that optimistic communication is observed for both past and future performance; however, difficult macroeconomic environments tend to engage more open and optimistic communication.

Focusing on the financial statement contents of UK companies, Wisniewski and Yekini (2015) argue that the Diction variables 'Activity' and 'Realism' predict future returns, even after they controlled for a number of firm-specific and accounting variables. Similarly, Li (2010) also found that even after controlling for other determinants of future performance, there is a positive relationship between the tone of forward-looking statements and future

performance. Similar to these approaches, Yekini et al. (2016) also used Diction's user-defined dictionary to produce a database of positive and negative sentiments within UK companies' financial statements and then explored market reaction to these. They found that positive sentiments communicated via company annual reports led to abnormal returns around the disclosure date.

Barkemeyer et al. (2014) used Diction to explore whether corporate sustainability reporting corresponds with corporate sustainability performance as observed in financial reporting. Exploring Diction's certainty and optimism variables, they found that CEO communications in sustainability reports do not seem to accurately reflect corporate financial performance. Using a database of 26,000 earnings press releases from S&P 500 companies, Arslan-Ayaydin et al. (2015) used Diction to explore the linkage between the tone of these communications and the firm's stock price. They argue that the tone of earnings press releases tends to be more positive as the portfolio value of managers is more closely tied to the firm's stock price. They further argue that as managers' equity incentives rise, investors react proportionally less to the tone present in the earnings press releases.

In an attempt to capture the effect of investor news sentiments on the Taiwan Stock Exchange, Wei et al. (2017) constructed an 'aggregate news sentiment index' from Diction's optimism and pessimism variables. They found that their news sentiment variable tended to increase the trading value of stocks as well as reduce the investor fear gauge of the Taiwan Volatility Index (TVIX). Harford and Schonlau et al. (2017) used Diction to propose a new understanding of the corporate debt maturity structure using the software's measure of optimism and certainty as a gauge of overconfidence. They hypothesised that managerial overconfidence would increase debt maturity by mitigating the underinvestment problem, which is often a concern for long-term debt holders. They found that overconfidence in the CEO's communication reduces the underinvestment problem, which subsequently has an impact on debt maturity. Cho et al. (2010) used Diction to evaluate the relationship between corporate environmental disclosure and actual firm environmental performance. They found that firms that were worse environmental performers used more optimistic language, therefore implying that a selective tone is used to compensate for their lack of performance. They also found a negative relationship between certainty in communicating environmental disclosure and environmental performance, implying that worse environmental performers mask their performance by using less certain language.

Craig and Bennis (2012) used Diction to analyse the links between CEO communication and corporate reputation. Using six Diction variables, they found that

reputation was positively related to sentiments such as ‘reality’ and that company size played a significant role in corporate reputation. Harford and Schonlau (2013) used Diction’s praise and blame variables to examine the ex-post quality of acquisitions and found that CEOs were generally not penalised for bad acquisitions but were rewarded for good acquisitions in what was described as an ‘option-like payoff’. Using the negative words lists from Diction to construct a measure of conservatism, Ferris et al. (2012) analysed 1,175 IPO prospectuses and found that conservatism was positively related to under-pricing and negatively related to firms’ operating profit for three years after the IPO.

Notably, Diction has also been used within the context of economic theory to explain new behavioural economic biases. Hilary et al. (2016) developed a rational economics framework to analyse over-optimism and overconfidence in managers of large firms. They argued that economic theory suggests that decision making amongst managers begins with subjective beliefs about different possible states of the world under a Bayesian approach and beliefs are updated as more information is received. Therefore, for each action a manager takes, the manager’s prior belief over the likelihood of success is equal to the true probability plus a random error, which they argue generates a static over-optimism. Using Diction to capture optimism scores, they focus on managerial forecasts of a firm’s quarterly earnings and argue that managers become dynamically over-optimistic after a series of recent successes. Some of their key findings suggest that managers who have been successful in the past have the tendency to be over-optimistic about the future. These analogies relate very much to central bank policy makers as well, given that they also put information about their perception of future economic performance and in the process may exhibit over-optimism biases if there have been past economic successes under their watch.

Finally, some research has specifically used Diction to analyse central bank communication in a manner that is similar to our work. Born et al. (2012), while evaluating the role that central bank communication plays in macroprudential supervision, used Diction to capture optimism in financial stability reports (FSRs) and speeches and found that financial markets reacted to the tone of optimism in these communications. They found that increased optimism tones in speeches and interviews tended to raise volatility in financial markets while FSRs reduced market volatility. Similarly Born et al. (2014) used Diction to construct a much broader database on the optimism score of 1000 FSRs, speeches and interviews across 37 central banks and find consistent evidence that increased optimism in FSRs calmed stock markets while speeches and interviews seem to increase market volatility. Sections of our work are somewhat similar to the above as we also seek to capture the level of optimism in MPC

minutes and inflation reports and evaluate amongst other things, its onward effects on the macro economy.

3.2.2 Methodology used by Diction

Diction² is a computer-aided textual analysis software programme that uses a series of integrated dictionaries to examine a text for five semantic features: *certainty*, *activity*, *optimism*, *realism* and *communalism*. These five semantic features are also called master variables and Diction calculates a standardised and raw quantitative value for each of these. To analyse a text, the software uses an over 10,000-word search routine of word lists (or dictionaries) formulated from 31 sub-variables (or sub-dictionaries) to categorise texts into the five main master variables. The master variables are composed by converting all subaltern variables to z-scores, combining them via addition and subtraction, and then by adding a constant of 50 to eliminate negative numbers. The process of deriving the five main master variables from the 31 sub-variables is fully automated, therefore ensuring that all relevant sub-dictionaries are used in the process. It is important to note that the word lists that make up each sub-dictionary cannot be edited, therefore ensuring that the findings of the Diction software are consistent across all studies.

Table 3.5 below shows a list of all the 31 sub-dictionaries. Some of the word lists that make up the dictionaries for these are subsequently highlighted in table 3.6. Given that we are unable to table all 10,000 words, we highlight some of the texts that make up each of the dictionaries of the sub-classifications for information only. Each sub-variable's dictionary can contain as much as 745 words but we will only be highlighting about 20 words per sub-variable.

² Diction 7.0 was used in this research.

Table 3.5: List of Diction sub-variables (sub-dictionaries)

<i>Numerical Terms</i>	<i>Communication</i>	<i>Diversity</i>
<i>Ambivalence</i>	<i>Cognition</i>	<i>Exclusion</i>
<i>Self-Reference</i>	<i>Passivity</i>	<i>Liberation</i>
<i>Tenacity</i>	<i>Special Terms</i>	<i>Denial</i>
<i>Levelling Terms</i>	<i>Familiarity</i>	<i>Motion</i>
<i>Collectives</i>	<i>Temporal Terms</i>	<i>Centrality</i>
<i>Praise</i>	<i>Present Concerns</i>	<i>Rapport</i>
<i>Satisfaction</i>	<i>Human Interests</i>	<i>Cooperation</i>
<i>Inspiration</i>	<i>Concreteness</i>	<i>Hardship</i>
<i>Blame</i>	<i>Past Concerns</i>	
<i>Accomplishment</i>	<i>Aggression</i>	

In this research we focus mainly on the optimism and uncertainty master variables. To provide some context on the size of the word lists associated with our variables of interest, we explored the optimism variable in more detail and found that there were approximately 1,606 words associated with the optimism variable. This wide-ranging word list provides great credibility for our measures of tone used in this research. Specifically, the optimism and certainty variables are calculated using the following formulae which incorporate other sub-variables as shown below.

$$\text{Optimism} = [\text{praise} + \text{satisfaction} + \text{inspiration}] - [\text{blame} + \text{hardship} + \text{denial}] \dots(3.3)$$

$$\text{Certainty} = [\text{tenacity} + \text{levelling} + \text{collectives} + \text{insistence}] - [\text{numerical terms} + \text{ambivalence} + \text{self reference} + \text{variety}] \dots(3.4)$$

Diction then converts these variables to z-scores and adds a constant of 50 to eliminate negative numbers. Furthermore, to account for homographs (i.e. words that are spelt alike with different meanings), Diction implements a statistical word disambiguation technique by applying (*a priori*) statistical norms based on the frequency of homographs differentially weighted within its various dictionaries. This controls for the context of word use to some extent. Therefore, in a text that is tagged with the ‘business report’ norm, words such as ‘axes’ will align towards graphical axes rather than the plural of an axe. Our study uses the ‘business

report’ norm for all our analysis due to similarity between reports of this nature and central bank policy communications.

Table 3.6 below shows some examples of word lists contained in the sub-dictionaries used in the derivation of our optimism and uncertainty variables as described by equation 3.3 and 3.4 above.

Table 3.6: Sample word lists listed in Diction Sub-Dictionaries

Sub-dictionary	Sample word lists
Praise	brave; blessed; intelligent; reliable; greater; bright; glorious; noted; nice; lovely; cheerful; right; favourable; attentive, creative; clearer; admirable; favourite; exalted; magnificent; entertaining; vigilant.
Satisfaction	cozy; satisfied; havens; thrilled; prouder; amazement; parental; entertain; hopefully; fortunately; exalting; triumph; pride; thanks humour; cordial; favourable.
Inspiration	nobility; reason; probity; purity; enrichment; concern; supremacy; sanctity; sacrifice; zeal; loyalty; devotion; worth; responsibility; commitment; honour, authenticity.
Numerical terms	calculated; halves; subtracts; multiplied; numeral; thousands, duplicates, numerous; bisects; tenfold; discount; geometry; digit; ratio; deducts; computation; counts; digital; numbers; equation; quotas.
Ambivalence	reputedly; appear; ambiguity; although; something; confounded; suggest; doubting; partial; presume; alleged; purportedly; could; dubious; seemingly; confused; guess; hesitating; blurs.
Self-reference	I’ve; I’d; I’ll; myself; mine; me; I’m; my; I.

Sub-dictionary	Sample word lists
Tenacity	does; have; must; been; has; was; were; are; do; had; be; is; did; shall; will; having; they've; she'll; he'll; hasn't.
Levelling terms	total; inevitable; everyday; everything; indisputable; fixed; obvious; evident; permanently; entirely, manifestly, fully, continuous, unqualified, cornerstone, indeed, decidedly; constantly, adamant; utmost; assuredly.
Collectives	alliance; congregation; citizenry; council; corporation; legislature; syndicate; grouping; gathering; government; industry; generation; brigade; bureau; hosting; board; confederation; system; category.
Praise	brave; blessed; intelligent; reliable; greater; bright; glorious; noted; nice; lovely; cheerful; right; favourable; attentive, creative; clearer; admirable; favourite; exalted; magnificent; entertaining; vigilant.
Satisfaction	cozy; satisfied; havens; thrilled; prouder; amazement; parental; entertain; hopefully; fortunately; exalting; triumph; pride; thanks humour; cordial; favourable.
Inspiration	nobility; reason; probity; purity; enrichment; concern; supremacy; sanctity; sacrifice; zeal; loyalty; devotion; worth; responsibility; commitment; honour, authenticity.
Blame	agitated; craziest; threatening; inhuman; apprehensive; detrimental; bleak; monstrous; uglier; sorrowful; cynical; troubled, sour; unnecessary; absurd; vulnerable; silliest; despotic; berserk, abrasive.

Sub-dictionary	Sample word lists
Hardship	threat; folly; mistrusting; sinning; indignation; storm; failing; traumas; cyclone; conspiracies; hunger; pained; recession. Naught; stressing; deaths; panic; stupidity; overwhelm; betray; despot; deception; troubles; torments; bankruptcy.
Aggression	controlling; bumpy; vetoed; upheaval; defended; compete; overturn; aggression; knock; conquering; collision; overthrowing; defeating; explosions; eradicating; assertive; blocking; pre-empts; violated; prodding; attacks; confronts.
Accomplishment	occupied; developed; profession; advances; creates; managing; duties; producers; achieving; locates; effects; purchases; capitalise; accomplishing; mould; drove; handling; leave; grew; acted.

When a text is entered into the software to analyse its tone, the software aggregates the lists of words associated with each of the sub-dictionaries above and then uses the formulae highlighted in equations 3.3 and 3.4 above to assign a score to the master variables. Given that the software uses a 10,000-word list that has been derived using extensive research, this automated method is more effective than studies that use manual word lists. It is important to note that Diction® focuses mainly on one-word dictionaries rather than phrases or hyphenated words. Therefore, words such as first-quarter are merged as one word and for this reason we eliminate hyphens when cleaning up our texts for analysis.

As Loughran and McDonald (2011) highlight, the use of dictionary methods has several advantages, most notably, the fact that once a third-party dictionary is being used, the risk of bias being introduced through researcher's subjectivity is minimised. Although four main dictionaries (word lists), namely Henry (2008), Harvard's General Inquirer (GI), Diction, and Loughran and McDonald (2011), have been used in the related field of accounting and finance, none of these offers the scale of words available in Diction's word lists. Similarly, studies in economics that have used dictionary methods for research, have used individually constructed

word lists which are very limited in the scope of their word lists. Furthermore, most studies that use dictionary methods focus on binary variables such as ‘positive’ and ‘negative’ tones rather than the array of variables offered by Diction.

Given that lengths of texts analysed will vary in terms of word counts, Diction accommodates for this by creating 500-word average breaks for longer texts and extrapolating the data for shorter texts to a 500-word norm. Diction highlights that the choice of 500 words as the optimal word length for textual analysis is backed by research which suggests that it takes an average of 500 words to get an accurate understanding of a person’s overall style or of an organisation’s general language habit.

There are further aspects of the Diction software that make it a unique textual analysis programme and help fine-tune our textual analysis. One such tool is the insistence score, which the software uses to measure the extent to which a text stays on topic. To measure this, the software prompts the researcher - at the point when texts to be analysed are being uploaded – to identify all the nouns and noun-derived adjectives related to the topic of research. . The software then measures the extent to which these identified nouns and noun-derived adjectives are heavily repeated in a text. This tool helps researchers ensure that the texts they are analysing are fairly similar across the board. For our research, we identified all key nouns and noun-derived adjectives common to central bank communications such as inflation, growth, interest rates, headwinds, committee, trends and economy, to mention a few. We then explored whether all the MPC communications and inflation report communications had a similar insistence score. We found our insistence scores to be largely similar for all the communications documents explored, which therefore signifies that most of the communications stay on topic and are discussed within a similar context. The implication of having an outlier with a text’s insistence score is that such a text is likely to have been written in a very different context and may provide an inconsistent result if analysed along with the other texts, e.g. analysing a poem alongside an MPC communication.

The software also uses a built-in database of over 50,000 texts which have previously been analysed over forty years of research to classify texts into norms. For instance, the user may apply general text norms or select from about fifty sub-categories which include business reports, speeches, newspaper editorials, business reports, scientific documents and telephone conversations, amongst others. The norms help the software to contextualise text and also allow for a comparative analysis of texts based on the norms used. In this study, we applied business report norms given that we assumed substantial similarities between well-written business reports and central bank communications.

3.2.3 Some practical examples of text optimism using Diction

To highlight how tone, as captured by Diction, can vary between text, we examined a number of text samples from MPC minutes (see table 3.7). For this exercise, we compared the most optimistic policy text from April 2004 to the least optimistic policy test from January 2003 and manually highlighted optimistic and pessimistic statements from both texts using a colour code. Optimistic sections of the text are labelled green and pessimistic sections of the text are labelled red. The policy deliberation in April 2004 which followed the first rate rise in over three years clearly showed that committee members were generally optimistic about the outlook of the economy. When we evaluated the January 2003 deliberations, which followed concerns from international political tensions and the spillover from the weakening German economy, we observed a much less optimistic policy communication. These variations in optimism can also be seen clearly from the colour coded tags which we applied to the text, with the green outweighing the red in the high optimism text and vice versa in the low optimism text.

Table 3.7: Comparison of high optimism and low optimism texts

High optimism text	Optimism score	Low optimism text	Optimism score
<p>The Committee's February inflation projection at constant interest rates had indicated that CPI inflation was likely to be rising at and beyond the two-year horizon. The broad economic outlook had not changed very much since then: it seemed likely that the economy was still growing above trend and there was not much spare capacity. But that analysis did not by itself imply that a repo rate rise was necessary immediately.</p> <p>There were, however, a number of arguments for increasing the repo rate this month to which different members attached different weights. First, some downside risks to inflation had diminished. The first rises in rates since February 2000 did not seem to have had a disproportionate effect on household consumption and borrowing so far, so the argument for caution, which had seemed persuasive in November, now appeared less relevant. Also, for some members, the latest US non-farm payrolls data were an indication that the downside risks to US consumption growth had diminished. Second, a rise this month would not be a major surprise in financial markets, so</p>	54.36	<p>The Committee agreed that, although there was a wide range of information to take into account this month, the net impact of the news was difficult to assess. The world economy was on balance slightly weaker. The overall news from the United States might be slightly on the upside taking account of the fiscal package, but the euro area, especially Germany, was weaker. Some Committee members remained concerned that weak confidence in Germany might begin to spill over to other countries in the euro area. The effects of the current international political tensions were not clear, although they might be having some dampening effect on survey indicators of confidence, and perhaps also on demand, both in the rest of the world and the United Kingdom. In the United Kingdom, there had been some signs that retail sales growth had been sluggish in early December, but it had probably since picked up and the recent underlying trend in consumption was not yet clear. There were some tentative signs that the rate of increase in house prices was moderating. Both these developments had been expected to materialise at some stage. Output growth had recently been around trend, and there was no sign in the</p>	46.4

there was less danger of triggering an upward shift in the sterling yield curve or effective exchange rate. Third, a rise in rates now might help to discourage unsustainable rates of house price inflation. That would address an upside risk to consumption in the near term and also reduce the risk of a sharp correction to the housing market and to consumption later. Were such a correction to take place, that might pose difficulties for the Committee in keeping CPI inflation close to the 2% target. One member put particular weight on possible future complications for the Committee arising from the increased vulnerability of the household sector to shocks due to the continuing increase in its debt relative to disposable income to historically high levels. That member also argued that the still-high growth rate of secured and unsecured debt pointed to continuing robust consumption growth in the near term.

There were also several arguments for maintaining the current repo rate this month. First, although it would be appropriate to withdraw some of the monetary stimulus in due course, it did not at present appear necessary to raise rates faster than the profile implied by the market yield curve in February. The February projection on the market interest rate assumption had suggested that inflation would undershoot its target at the two-year horizon, and would be unlikely to exceed it by a significant amount further out. Since February, UK-weighted world demand prospects had weakened slightly, but the strengthening UK housing market had raised prospective consumption and aggregate domestic demand growth. Offsetting this had been the rise in sterling, which had not fallen back towards its level at the beginning of the year and hence warranted more weight this month than last. Taken together, those factors suggested little change to the February inflation projection. For some members, certain downside risks to inflation had increased. For instance, euro-area domestic demand showed little sign of increasing at the pace that would be necessary by the second half of the year to be consistent with the Committee's projections. Geopolitical risks to world demand might also have increased. Second, although the current inflation rate was below the target, interest rates had already been increased in anticipation of rising inflationary pressures. The fact that inflation expectations remained firmly linked to the target reduced the risks of delaying any further move in rates. The Inflation Report next month would provide an opportunity to evaluate the mixed economic news and reconsider some of the

monetary or labour data that the economy was about to weaken abruptly, despite the gloomy tone of some recent commentators. RPIX inflation looked likely to be a little stronger in the near term than at the time of the Inflation Report, but this was as a result of factors which seemed likely to be temporary.

Most members had taken the view at the December meeting that inflation was broadly on track to meet the target in the medium term and that the risks around the projection were roughly balanced. For these members, the information received this month, taken together, did not contain a clear message about the prospects for inflation. Various arguments, to which different members attached different weights, supported this judgement. First, although the balance of indicators on the world economy was probably negative on the month, the impact on UK inflation in the medium term might be relatively limited. And in the event that the downside global risks were to crystallise, there was scope for policy responses overseas to support activity. Second, house price inflation looked likely to be stronger in 2002 Q4 than projected, although there were some signs of the long-expected slowdown. Third, the evidence that consumption growth was moderating, as had been envisaged in the November Inflation Report projections, was still tentative, and the monetary data suggested that growth in credit would support consumption and, possibly, investment. Fourth, the depreciation in sterling relative to the Inflation Report assumption, and the substantial fall in short and medium-term interest rates relative to market expectations at that time, would support activity and tend to increase inflation if they were sustained, although the fall in equity prices would moderate this to some extent. Overall, both monetary and fiscal policy were already supportive. Finally, the recent diverse news – about the world, about the domestic economy, and from financial markets – could be assessed more fully in the forthcoming forecast round. These arguments, taken together, implied that no change in the repo rate was needed this month.

Some members, however, continued to believe that an immediate repo rate reduction was warranted. First, these members had and still thought that the most likely path for inflation over the next two years would be slightly lower than the central projection in the November Inflation Report, and that the balance of risks lay on the downside. Second, the balance of news from the world economy over the past two months had been negative; there were longer-term downward pressures on world inflation coming from increased international

<p>unresolved economic issues, such as the reasons for the pickup in house prices and the relationship with household spending and borrowing. It would also provide a better opportunity to explain the Committee's thinking. Overall, most members put more weight on the arguments, taken together, for not raising the repo rate this month.</p>		<p>competition; and there were significant downside risks, in particular from the euro area, where consumer confidence was weak. Third, the upside risks to inflation were modest, with labour market conditions benign, and consumption and house price increases moderating. Finally, on this view, the risk of an unsustainable build-up in household debt and the current account deficit might not be as severe as some thought, and, in any case, should not prevent a repo rate reduction which was needed to support activity and maintain inflation close to target in the medium term. The current account was around its average level of the past four decades, and the household sector had been close to financial balance in recent quarters.</p>	
---	--	--	--

Despite the expansive scope of Diction's word list and the automated nature of the software, there are some limitations to employing the software that are worth noting. The most obvious of this is that Diction does not provide more information regarding a text beyond the output of the master variables analysed; therefore, the software is not capable of further meta-textual analysis. Other dictionary-based approaches such as WordNet have been found to have the ability to explore lexical, syntactic and semantic information and allow researchers to move from subjective or contextual groups to more general semantic groups that reflect deeper meanings inherent in particular words.

3.3 Text processing approach used for textual analysis

This section of our work highlights the process used to process and convert the texts we focus on into quantifiable variables. As previously highlighted, the communication documents we focus on are mainly MPC minutes and inflation reports from the Bank of England. We focus particularly on MPC minutes as they present the Bank with a regular opportunity to give insights into its thinking to the general public. As Blinder et al. (2008) highlight, 'Central banks often provide substantially more detailed explanations of monetary policy decisions in the minutes of policy meetings' (p. 32). For the MPC minutes we focus mainly on policy deliberations and therefore eliminate all introductory text and appendices. For inflation reports, our text extraction process is much more complex as inflation reports are often very extensive and contain several sub-sections with a significant amount of text and diagrams. We therefore focus on elements that we deem to provide market participants and other

stakeholders relevant information. Specifically, we extracted texts related to the overall introductory summary section and the associated summaries related to each of the analysis of ‘recent developments in inflation’, ‘money and interest rates’, ‘demand and supply’, ‘the labour market’, ‘pricing behaviour’ and ‘prospects for inflation’.

In order to process text from these sections of the communications, once we extracted them from the original publications published on the Bank of England website we then converted them to plain text (.txt) formats. As with all textual analysis procedures, it is important at this stage to explore linguistic processing of text to ensure that as much objectivity as possible is achieved with the extracted text. Such linguistic processing involves techniques such as lemmatisation or stemming, part of speech categorisation and word disambiguation techniques. Some of this linguistic processing, such as alignments of homographs and text norms, is automatically carried out by Diction, as highlighted below.

Before importing the texts for analysis, we manually carried out some further text processing primarily aimed at de-hyphenating the texts. We also ensured punctuation was correctly specified, thus making text processing more accurate. To do this, we manually perused the texts to remove all hyphenated words given the implications of such words for both the readability statistics and the Diction software. With readability statistics, eliminated hyphens between words reduce the perception of complexity from seemingly complex words which are often in reality, two simple words hyphenated together. With Diction, the software focuses mainly on one-word dictionaries rather than phrases or hyphenated words so eliminating hyphenated words makes our results more reliable.

Diction automatically stems words by merging words such as say, saying and said into the same lexical context. With homographs (words that are spelt alike with different meanings), The opportunity to implement word disambiguation techniques by applying (*a priori*) statistical norms based on frequency of homographs differentially weighted within its various dictionaries makes the Diction software quite unique in analysing texts. This controls for context of word use to some extent. Therefore, as highlighted previously, in a text that is tagged with the ‘business report’ norm, words such as ‘axes’ will for instance align towards graphical axes rather than the plural of an axe. Our study uses the ‘business report’ norm for all our analysis due to the similarity between reports of this nature and central bank policy communications.

There are further aspects of the Diction software that make it a unique textual analysis software and help fine-tune our textual analysis. One such tool is the insistence score which the software uses to measure if a text stays on topic. To measure this, the software prompts the

researcher to identify all the nouns and noun-derived adjectives related to the topic of research at the point when texts to be analysed are being uploaded. Once these have been identified, the software then measures the extent to which these identified nouns and noun-derived adjectives are heavily repeated in a text. This tool/facility helps researchers ensure that the texts they are analysing are fairly similar across the board.

For our research, we identified all nouns and noun-derived adjectives common to central bank communications such as inflation, growth, interest rates, headwinds, committee, trends and economy, to mention a few. We then explored whether all the MPC communication and inflation report communications had a similar insistence score. The evidence from this process suggested that the insistence scores for all the communication documents we used were quite similar, therefore signifying that most of the communications stayed on topic and were discussed within a similar context.

For both textual analysis programmes used, there are no restrictions to text structure on importing, although Diction automatically restructures texts into 500-word structures before analysing texts. Additionally, both Readable and Diction are automatic hard-coded software programmes that do not allow the researcher to code their own outputs, rather they have to rely on the outputs provided by the software. Once the texts have been cleaned out and converted to plain text format and imported into the Readable and Diction programmes, they are processed and output in quantitative CSV format. These are then collated as time series data and are ready for analysis. As with a number of textual analysis software programmes, the software used in our research hardly goes beyond the text nor does it provide any further meta-textual information; our analysis is instead based on analysis of the outputs in conjunction with other variables of interest. The other macroeconomic data and variables used in this study are described further in subsequent chapters.

3.4 Conclusion

This chapter explored the data on complexity and tone of communication, the motivation for using these and how these were derived. In the first instance we explored the complexity of text using readability statistics and presented background information about how readability statistics are calculated and what they seek to capture. To do this, we explored a number of sample texts that showed the characteristic differences between the sample texts. We showed that complex text as captured by readability statistics have attributes such as increased sentence length and word length that make them inherently more complex to read.

We further highlighted that although readability statistics have been popularly used to analyse text complexity, there are certain limitations within its use that should be considered.

We further explored the derivation of our data for the tone of communications, which mainly focus on optimism and uncertainty as captured by the computer-aided text analysis software Diction® that we used in this research. To highlight the credibility of Diction® in academic research we provided background information about some of the studies have used this software. We then discussed the working of the software in more detail by highlighting the 31 sub-dictionaries and the formulae used by the software to derive our variables of interest. Examples of the word lists from these dictionaries as well as specific functionalities that helped us derive our data such as the stemming, normalisation and insistence techniques were also discussed in more detail. As with complexity, we provided some practical examples of what the software seeks to capture by comparing texts from optimistic and less-optimistic scenarios. We also highlighted the limitations of using the software for textual analysis and obtaining our data. Finally, the chapter highlighted the step-by-step approach used to prepare our data for analysis as well as the sources of the texts we use. Our work mainly focuses on communication from the Bank of England in the form of MPC minutes as well as inflation reports. The specific sections of the documents that are extracted for analysis were described and briefly justified.

CHAPTER FOUR

4.0 THE EFFECTS OF MACROECONOMIC CONDITIONS ON THE COMPLEXITY AND TONE OF CENTRAL BANK COMMUNICATION

4.1 Introduction

This section of our work seeks to explore the role that macroeconomic conditions play in driving the complexity and tone of central bank communication and addresses our research questions (X1 and X2, in figure 1.2 above) on the time-varying nature of complexity and tone of communication as well as our research question on the behaviour of central bank communication under varying macroeconomic conditions. Put together, this section covers the back end analysis of how central bank communication can be fundamentally impacted as described in our model above.

In the first instance, we explore the time-time varying characteristics of the complexity and tone of central bank communication by deriving quantitative values of complexity and tone using the textual analytical methods described above and exploring the trends over our sample period. Our first hypothesis tests whether there are any observable trends in the complexity and tone of communication over our sample period. Secondly, we test whether there is any association between the levels of complexity and tone of communication and the prevailing macroeconomic conditions in which the communication is made. Furthermore, we try to ascertain if we can infer elements of transparency from the results obtained from our analyses. This particular element of our work is exploratory; however, we hypothesise that the time-varying trends of complexity and tone should reflect the general macroeconomic environment at the time of communication. For instance, our hypothesis would suggest that periods around the 2008 financial crisis should coincide with more complex statements, more uncertainty and less optimism in communication. We hypothesise that as an inflation-targeting central bank is required to explain significant deviations of its policy actions from its inflation target, the bank may be less clear, less certain and less optimistic when macroeconomic environments are unfavourable.

For the purposes of this study, we propose that for an inflation-targeting central bank, an unfavourable economic situation is one where prevailing inflation and forecast inflation are further away from the bank's inflation target, and exchange rate pressures lead to the depreciation of the local currency. Therefore, for an inflation-targeting central bank to be perceived as being transparent (i.e. communication reflecting the true state of the economy), our hypothesis above should hold true and consequently communication should be consistently

more complex, less certain and less optimistic as inflation (current and forecasted) moves further away from the inflation target and as the pound depreciates. There is also some empirical evidence that may support our hypothesis. Using a broad sample of countries, Crowe and Meade (2008) show that inflation-targeting central banks tend to exhibit less transparency when inflation is rising.

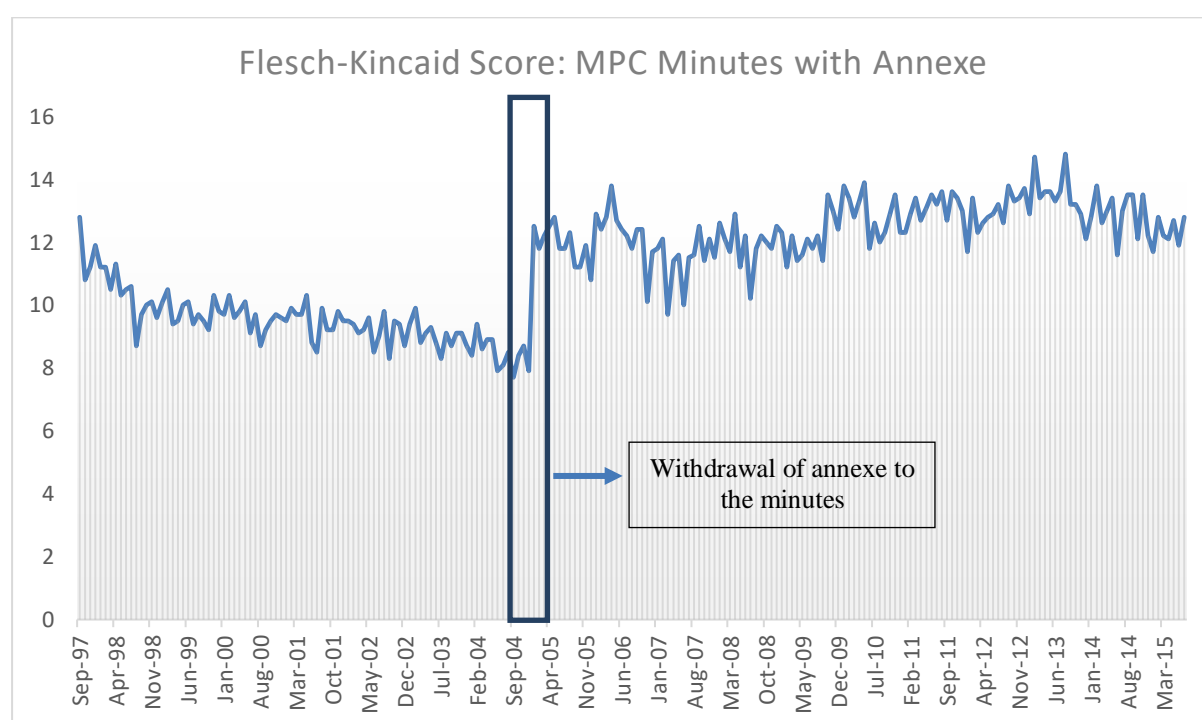
Specifically, we focus on monetary policy communications (MPC minutes) and inflation reports from the BoE which are carefully crafted and describes the bank's understanding of the current macroeconomic conditions. As discussed in chapter 3, our study uses readability statistics to capture complexity and we use the Diction software programme to extract measures of optimism and uncertainty of communication. Both of these data derivation methodologies and the techniques used for converting the text from the MPC minutes and inflation reports are by no means trivial and these are well described in chapter 3 above. Specifically, our study explores 214 MPC minutes and 72 inflation reports spanning the period September 1997 to July 2015.

Following our analysis, we document several interesting findings that have significance for policy makers within the BoE. Generally, we find significant evidence that the macroeconomic conditions in which the bank issues communication plays a vital role in the complexity and tone of the communication. Our core finding in this chapter is that we find evidence that rising inflationary pressures and depreciating sterling value have the tendency to increase complexity in both MPC minutes and inflation reports. In addition,, we also find evidence that rising inflation and widening contemporaneous inflation gaps tend to drive down optimism in MPC minutes and inflation reports. Finally, we find that uncertainty in communication driven by macroeconomic conditions is more evident in inflation reports than in MPC minutes. Both inflationary and exchange rate pressures impact the level of uncertainty in inflation reports whereas only the 2008 financial crisis impacted the level of uncertainty in MPC minutes. Interpreting these results in terms of transparency, we infer that where complexity of communication is considered, the BoE reacts in our hypothesised manner, thereby reflecting a significant level of transparency. The relationship between tone of communication and macroeconomic conditions only partially conforms to our hypothesised behaviour. The following sections document the process for obtaining these results as well as more detailed explanations of our results.

4.2 Analysing complexity of Monetary Policy Committee (MPC) minutes and inflation reports.

This section evaluates the data on complexity and tone derived from MPC minutes and inflation reports from the BoE. We start by evaluating data on the complexity of MPC communication over the entire sample period in order to explore longer-term trends in complexity of communication. It is important to note that there was a significant change in the communication regime in December 2004 after the removal of the annexe section which provided information that supported policy making by BoE staff. Our analysis of the complexity data on MPC minutes with sections of the annexe included shows that when the annexe section was added to MPC minutes, the overall complexity of monetary policy communication was reduced, as shown in figure 4.1 below.³

Figure 4.1: Flesch-Kincaid Grade Level for MPC minutes with annexe included – 1997 to 2015.



Given the obvious structural break in the trend of communication clarity and because the focus of our work is mainly on the carefully deliberated sections of the MPC minutes, our

³ Despite eliminating parts that we deem not to contain useful information, MPC minutes with annexe included still show lower readability scores.

work in this study therefore excludes the annexes from the MPC meetings.⁴ To this end, we strip all MPC minutes pre-January 2005 of the annexe section so that we can compare like-for-like communication and eliminate the apparent structural break in the complexity data. Figure 4.2 below shows the complexity data for core deliberations from the MPC minutes. To check for the reliability of our time series data here, given the potential for a structural break caused by a change in the communication regime, we statistically tested for structural breaks in the core MPC data using Chow's structural break test. Based on figure 4.1 above, we identified January 2005, when the communication regime changed, as a point of structural break and tested the null hypothesis that there was no structural break. Our analysis returned an F value of 2.35 which was less than the critical F value of 9.49, suggesting that we cannot reject the null hypothesis that there was no structural break in the core MPC data. Statistically, this implies that there is no evidence of a structural break in the core MPC data.

Figure 4.2: Flesch-Kincaid Grade Level for core MPC minutes – 1997 to 2015.

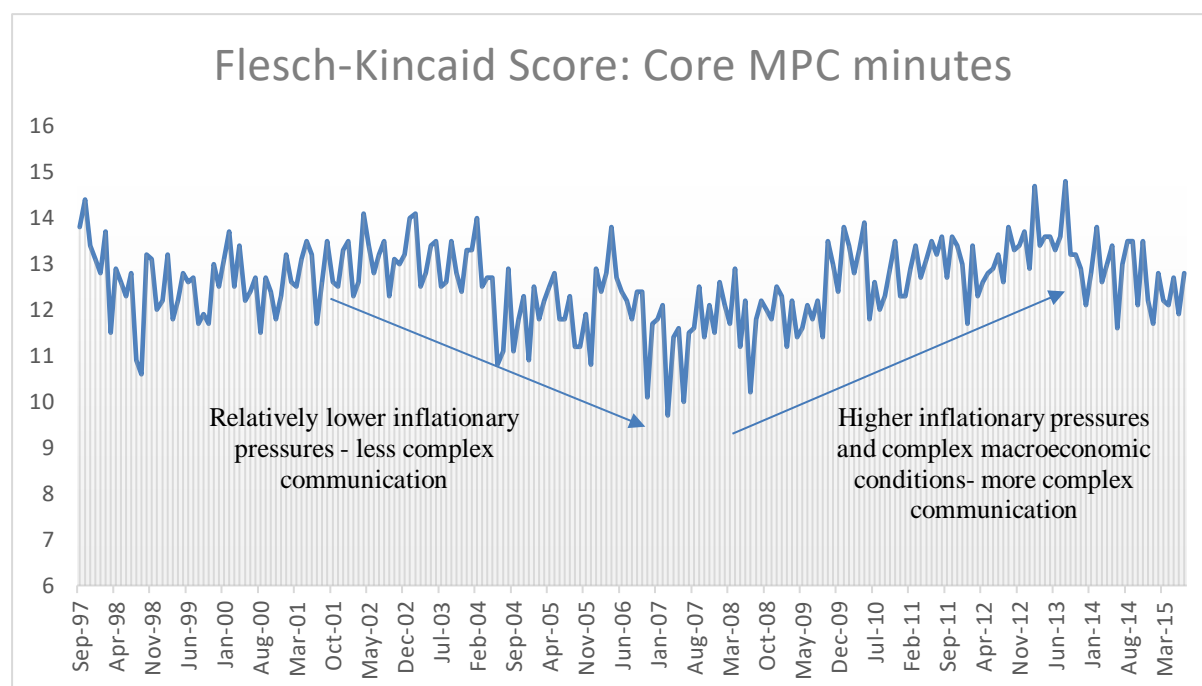
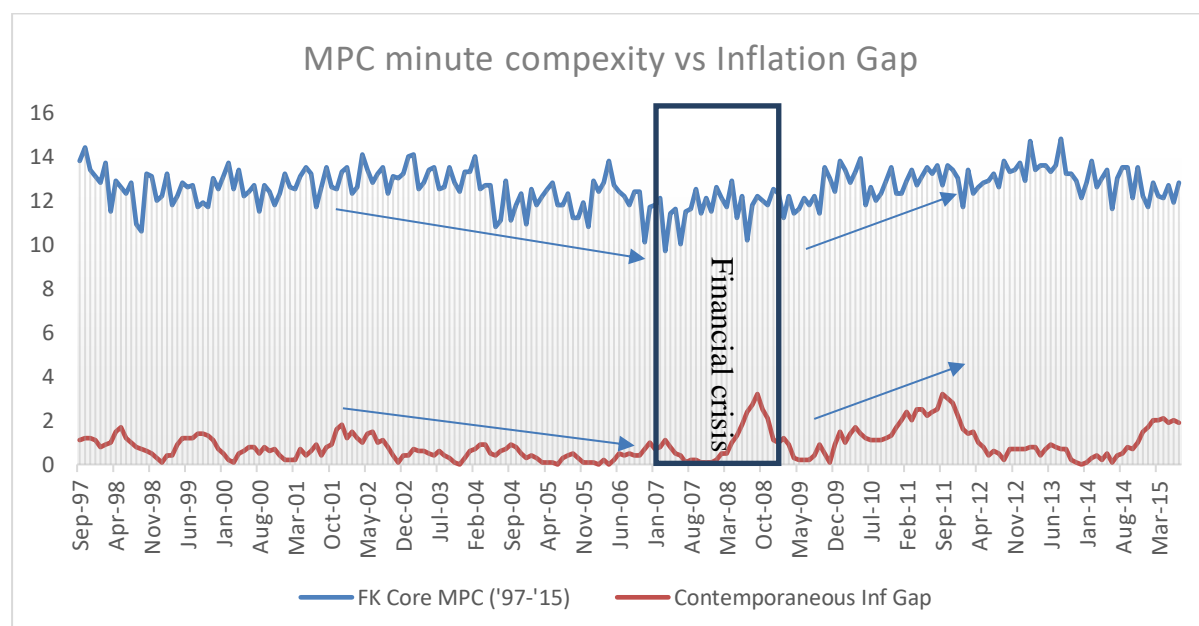


Figure 4.2 above depicts some trends which may be consistent with our notion that more difficult macroeconomic periods may be associated with more complex communication. As can be observed, the periods leading to the financial crisis in 2008 showed declining complexity of communication while the period following this critical point of the financial

⁴ Some analysis of the minutes with annexes are carried out in the appendix section as a means of exploring if they make any significant difference to our analysis.

crisis showed increasing complexity of communication. To evaluate this concept further, we compared inflationary pressures from the contemporaneous inflation gap (i.e. the difference between current inflation and the inflation target) and we observed that widening inflation gaps were associated with the post-financial crisis period, where communication complexity is increasing (Fig. 4.3). As we approach the period of the financial crisis, readability of communication dropped significantly to its lowest level, requiring only about 9.7 years of formal education in January 2007, compared to a peak of about 14.8 years in June 2013, after the financial crisis.

Figure 4.3: Comparison between MPC minutes complexity and contemporaneous inflation gap

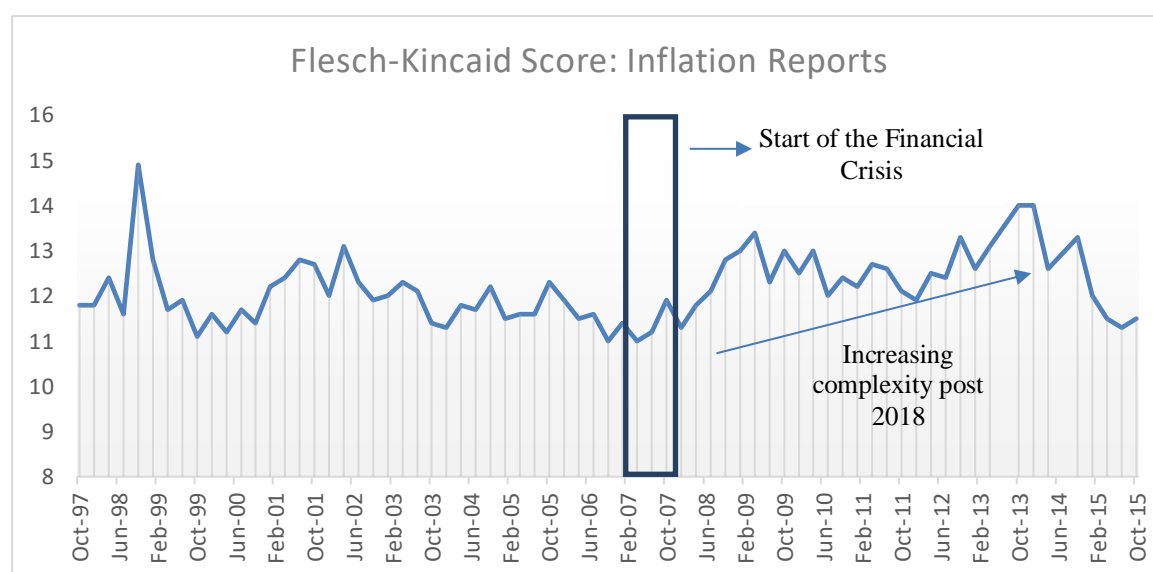


We also observed some seasonal patterns in the core MPC minutes which we suggest may have been caused by the existence of inflation reports in some quarters. Where the BoE releases MPC minutes in the same month as it releases an inflation report, there may be a tendency to include more or less complex information in the MPC minutes given that there is an alternative communication that month. Our subsequent analyses in other parts of our work take this into consideration when analysing the complexity of MPC minutes.

It may not be a straightforward task to clearly interpret the mechanics of these changes in complexity; therefore, we not only focus on the changes in the patterns of complexity as discussed above but rather, the variability in clarity in relation to the macroeconomic conditions in which the BoE operates. This analysis is carried out in the next sections of our work.

Next, we explore the BoE’s inflation reports which, although published less frequently than MPC minutes, give a deeper insight into the bank’s thinking. In each inflation report, the BoE often notes that the inflation reports serve two main purposes: first, that it provides a comprehensive and forward-looking framework which MPC committee members can discuss, therefore aiding their decision-making process and second, it serves as a means of putting out comprehensive information on the BoE’s thinking to the public and explains the reasons for its decisions to those that may be affected. With inflation reports, we explore the same period as explored with the MPC minutes, i.e. August 1997 to August 2015. We observed largely similar patterns to the MPC communication albeit with lesser variations in the complexity of communication. We find some of the highest complexity of communication to coincide with the immediate pre-financial crisis period and similar to MPC communication, communication becomes somewhat more complex with an upward trend following the financial crisis.

Figure 4.4: Flesch-Kincaid Grade Level for inflation reports – 1997 to 2015.



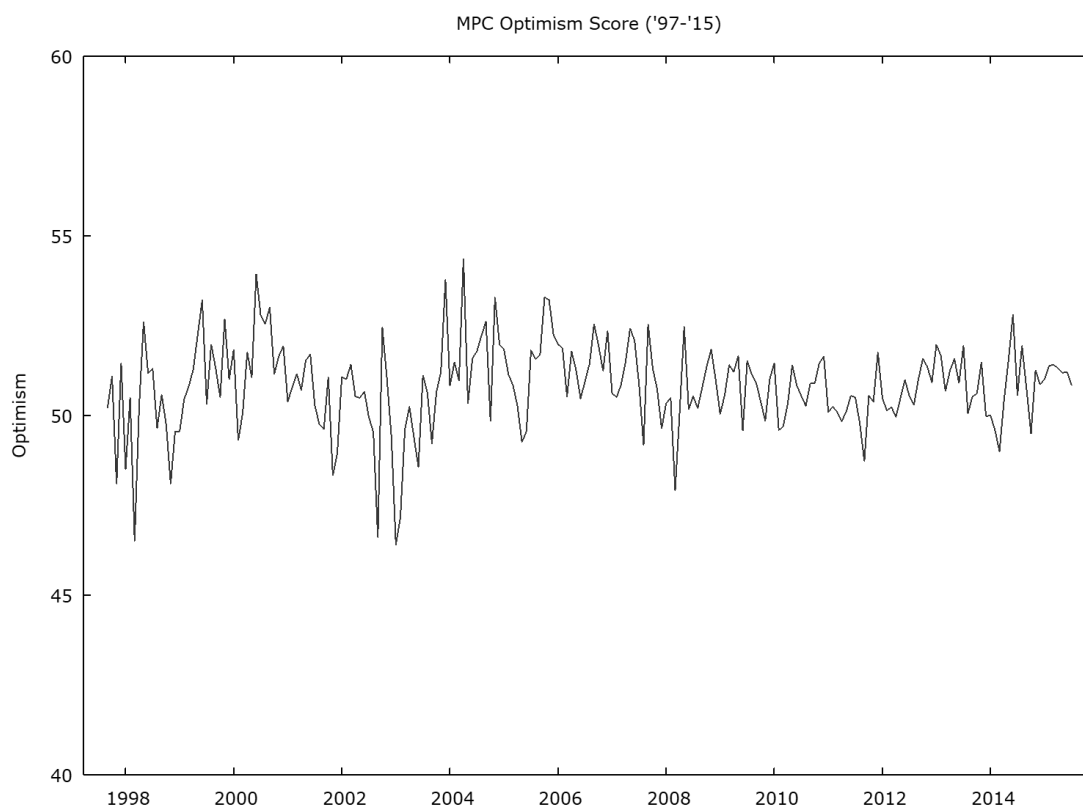
A few additional trends emerge from our preliminary analysis of the clarity scores for inflation reports. At first glance, the inclusion of forward guidance statements in some of the inflation reports seemed to increase complexity. In fact, we found evidence that the inclusion of a separate forward guidance section in the August 2013 inflation report increased complexity sharply to requiring 14 years of formal education, a level deemed too complex for public documents. Some of the trends we observe here are not as clear-cut as those observed with MPC minutes and there is evidence that some pre-crisis periods had very high complexity compared to some of the post-crisis periods. Nonetheless, we find preliminary evidence that

where we observed very high complexity, it may have been driven by underlying macroeconomic pressures. Indeed, our highest point of complexity was in the August 1998 inflation reports which followed the 1998 Russian financial crisis, which the BoE admitted caused a spillover effect that included sharp declines in equity prices across industrialised countries (including the UK) as well as increased spreads in corporate bonds, to mention a few.

To put this in context from a linguistic point of view, statements such as ‘Uncertainty about, and unwinding of, the exposures of financial institutions, especially after the near-failure of the Long-Term Capital Management hedge fund in September, led to reduced liquidity and increased volatility in financial markets’ tend to be complex due to several fragments of information contained therein that may confuse readers. From a clarity standpoint, a better approach would be to individually highlight the relationships between uncertainty and volatility, uncertainty and liquidity, unwinding and uncertainty, and unwinding and volatility. The foregoing analysis only describes the patterns of complexity observed with these communication documents, subsequent analysis will use more robust regression analysis to explore relationships between clarity and the macroeconomic environment in which the communication is made.

Similarly, we explore the trend of optimism scores over our sample period as depicted in figure 4.5 below.

Figure 4.5 Optimism score for MPC Minutes – 1997 to 2015.



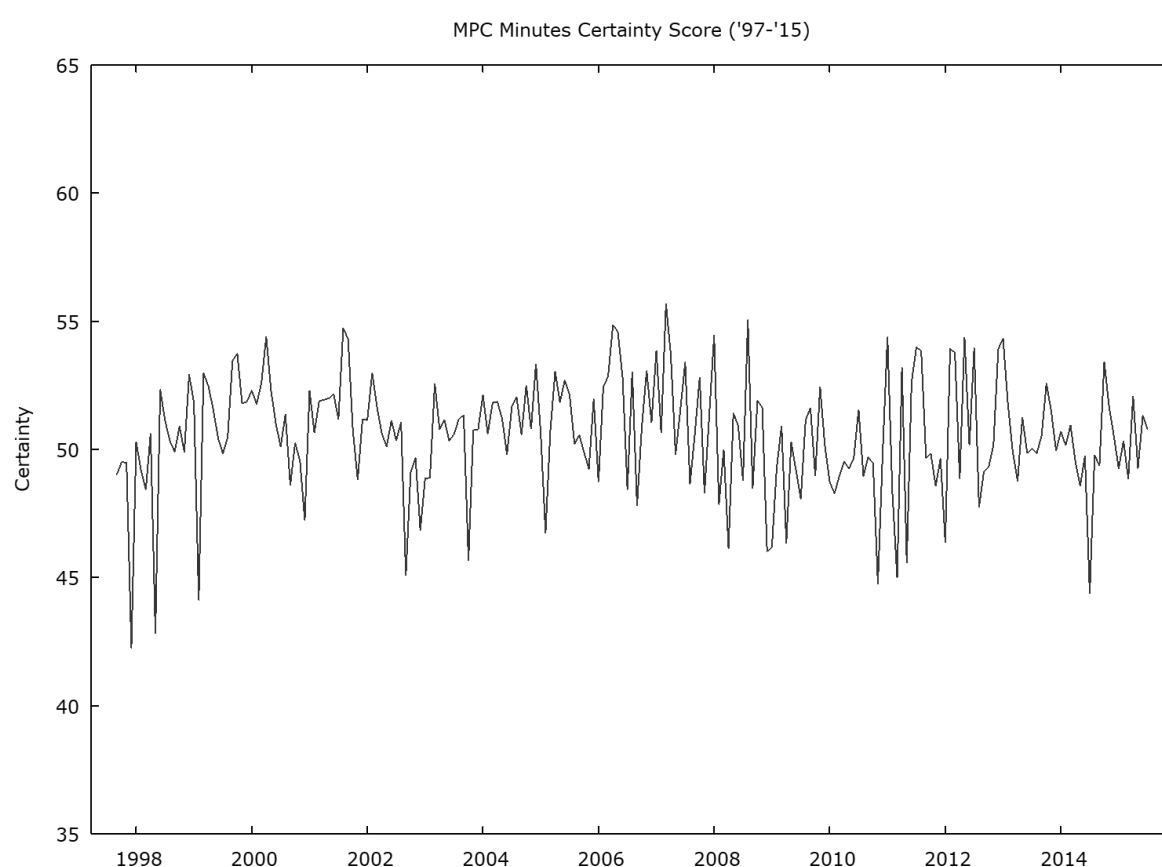
On initial evaluation, the graph shows that optimism scores do tend to show some correlation with some of the major world events that the BoE seemed to care about in their MPC deliberations. First, we observed low optimism scores in (i) 1997/1998, seemingly from concerns about the Asian/Russian financial crises and spill-overs from these. There were also extremely low optimism scores for part of 2002, which mainly seemed to have been caused by concerns about the stock market crash of 2002. Specifically, the introductory section of the August 2002 MPC minutes reads:

‘Over the month since the July MPC meeting, there had been further substantial falls in equity prices around the world. In domestic currency terms, the Wilshire index had fallen 4%, the Dow Jones Eurostoxx index 8%, the Topix index 7½% and the FTSE All-Share index 4%. Major indices (apart from Japan’s) were some 20% below the average levels used as a starting point in the May Inflation Report; and some of the ‘high tech’ indices were 30% or so lower. Indices had been more volatile, too, and uncertainty about future prices had risen, judging by the expected volatility implied by options prices.’

On the face of it, this introductory section of the minutes does seem to capture a pessimistic view of the world and this tone is carried on through the various sections of the minute as well. We also observed significantly low optimism scores during periods of the 2008/2009 financial crisis. Our econometric analyses below help to expand further on these relationships and on our observations.

Figure 4.6 below also shows the graphical trend of certainty captured within the text of the MPC minutes.

Figure 4.6: Certainty score for MPC minutes – 1997 to 2015.



The graph shows certainty to be lower (i.e. increased uncertainty) in some of the earlier years of our sample but overall, no specific was identified. Interestingly, some of the months with the highest certainty seem to cluster around the 2007/2008 period. It is difficult to evaluate these data and the resultant trends in isolation without the aid of more analytical work, therefore, our analysis section helps provide more insights into what may have been driving uncertainty in the BoE's policy making.

4.3 Macroeconomic data

Central bank communication may be sensitive to the economic conditions in which the communication is made and hence, when evaluating clarity of communication, economic developments should be accounted for. Previous studies such as Jensen (2011a) and Bulir (2013a), in evaluating the clarity of central bank communication have suggested that the macroeconomic conditions in which communication is made play a significant role in the clarity of central bank communication. Inflation-targeting central banks who have a mandate hinged on achieving a specified inflation target may particularly be under pressure from changes in the inflationary environment. To this end, the motivation for our choice of variables used in the analysis of our work mainly comes from some of the macroeconomic variables the BoE focuses closely on, namely variables linked to inflation as well as exchange rate variables. As Hendry (2001) highlights, policy makers in the UK are particularly sensitive to a depreciating pound as this has historically led to the notion of imported inflation, whereby the prices of imported goods and inputs into the production process (e.g. fuel) rise, which subsequently leads to inflation in the UK.

Additionally, through careful dissection of the MPC minutes and inflation reports, it can be observed that the BoE's major concerns often relate to four broad areas, namely: inflationary pressures, the financial markets, the international economy and often a section which captures issues such as 'money, credit, demand and output'. The inclusion of inflationary and exchange rate pressures as major aspects of the BoE's policy communication further affirms the need to explore the pressures that these key variables place on the bank's communication.

To capture inflationary pressures, our study uses three inflation-linked variables: the month-on-month rate of inflation growth; the absolute deviation of current inflation rate from the inflation target, which can be considered to be the contemporaneous inflation gap; and finally the absolute deviation of four quarter ahead inflation forecast from the inflation target, which can be considered as the forward-looking (ex-ante) inflation gap. To capture the exchange rate pressures, we simply use the GDP/USD exchange rate. Section 4.4 below explores the regression analysis we used to examine these.

4.4 The impact of macroeconomic conditions on clarity and tone

Following an approach similar to that of Bulir et al. (2013), we model complexity and tone as a function of the macroeconomic variables discussed above as:

$$C_{it} = \alpha + \beta_{\pi}\pi_t + \beta_{\pi c}|\pi_t - \pi_t^*| + \beta_{\pi e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_{\gamma}\gamma_t + \beta_D DIR + \beta_{FC} FC + \beta_T T_{it} + \varepsilon_{it} \quad \dots (4.1)$$

Where C_{it} denotes the relevant measure of complexity and tone of the communication of interest (i) (i.e. MPC minutes or inflation reports) at time t . The Flesch-Kincaid Grade Level score is used to measure complexity of communication, with higher values implying communication that is more complex and one in which a reader will require more years of formal education to comprehend. Diction scores are used to capture optimism and uncertainty tones, where higher values of the optimism score imply a more optimistic communication and a higher value of the certainty score implies less uncertainty.

π_t represents the current month-on-month growth rate of inflation and seeks to capture the inflationary pressures from inflation growth. Inflationary pressures from deviating further away from the inflation target in current period t is captured by the covariate $|\pi_t - \pi_t^*|$ and this is measured in absolute terms. This variable, which can also be termed the contemporaneous inflation gap, further captures the pressure on the bank from an accountability perspective given that the BoE's Governor is required to write an open letter to the chancellor if inflation deviates from the above inflation targets by one percentage point or more in either direction. The inflation target set by the chancellor's office was 2.5% between September 1997 and December 2003 and 2% from January 2004 to September 2015. Our second inflation covariate $E_t(\pi_{t+4}) - \pi_t^*$ captures the forward looking (ex-ante) inflation gap, which is the difference between the four quarter ahead inflation forecast and the inflation target.

γ_t is the value of the pound relative to the US dollar and captures the pressures from the depreciation of the pound. DIR is a dummy variable that takes the value of 1 in a month when inflation reports are released in addition to MPC communication and 0 otherwise. The reasoning behind the introduction of this variable is that in a month where there is further opportunity to put out communication via inflation reports, the bank may tend to reduce emphasis on certain issues in the MPC minutes so as to avoid repetition or double emphasis. This approach also accommodates for the seasonal trends we observed in our data, which we suggest were caused by the presence of inflation reports in certain months. However, this

variable is only included in our analysis of MPC minutes. Finally, the last two variables in our model FC and T capture the effects of the 2008 financial crisis and the time trend respectively.

It can be argued that the period of the financial crisis should significantly contribute to additional pressures on the clarity of the bank's communication. As Claride et al. (1999) argue, policy makers have been observed to act on instinct and without a theoretical rationale in the event of a financial crisis. They state the example of the stock market crash of October 1987 where the Federal Reserve reduced interest rates with the support of most economists but without theoretical justification for the intervention. To account for this effect, we introduced a binary dummy variable to capture the effect of the financial crisis in our model. Although there is no general consensus on the actual time the financial crisis hit, we used September 2007, the month in which Northern Rock sought emergency funding from the Bank of England, as the onset in our model and we extended this to the end of the last quarter of 2009. Our expectations were that the financial crisis of 2008 may have had a significant effect on the manner in which the central bank communicated over this period. The low readability scores observed for MPC minutes during this period makes a case for further analysis of the impact of the financial crisis on the readability of MPC minutes.

In line with our research questions, we tested two null hypotheses on the basis of the model above. In the first instance, we tested the null hypothesis (H_0) that 'there is no change in the trend of complexity and tone of the BoE's communication over our sample period'. The null hypothesis – H_0 is given as:

$$\begin{aligned} H_0: T_{it} &= 0 \\ H_1: T_{it} &\neq 0 \end{aligned} \quad \dots (4.2)$$

Where T_{it} is the linear time trend variable in equation 4.1 above.

Given the increased demand for transparency and accountability from the BoE, mainly from inflation-targeting practices as well as from the oversight of the Treasury Select Committee, our expectations were for communication to reflect less complexity over our sample period. This would also be in line with the transparency literature which suggests that inflation-targeting central banks have become increasingly transparent over the past few decades (e.g. see Dincer and Eichengreen, 2014 and Hovarth and Vasco, 2016). For tone, we did not propose an *a priori* on the trend of communication tone over our sample period.

In the second instance, we tested the null hypothesis (H_0) that there is no association between the complexity and tone of the bank's communication and the prevailing

macroeconomic conditions in which the communication is made. The null hypothesis – H_0 is given as:

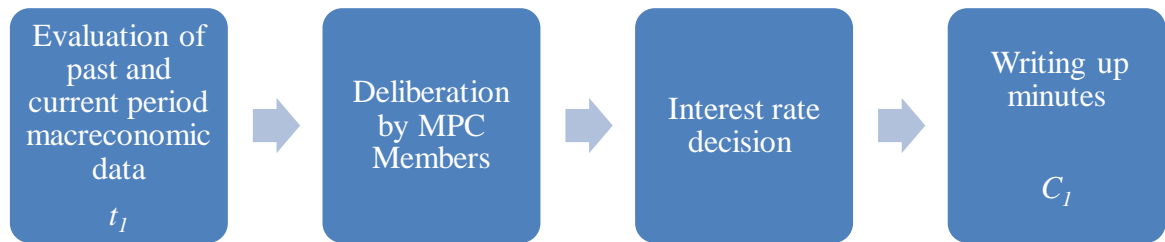
$$\begin{aligned} H_0: \beta_\pi &= \beta_{\pi c} = \beta_{\pi e} = \beta_\gamma = \beta_{Fc} = 0 \\ H_1: H_0 &\text{ is not true} \end{aligned} \quad \dots(4.3)$$

Where, π represents current inflation rate, πc represents the contemporaneous inflation gap, πe represents forward looking inflation gap, γ represents the pound/dollar exchange rate and β_{Fc} represents a financial crisis.

Our expectations were that given the need to be accountable and transparent, central bank communication would be impacted by the macroeconomic pressures around the time in which the communication was made. Specifically, as highlighted previously, complex situations, such as where there is a macroeconomic or financial crisis, may require the bank to put out more complex communication that reflects, to some extent, the complexity of the situation. Therefore, where inflationary pressures are rising and exchange rate is falling, there might be a tendency for communication to be complex. In addition, we proposed that such complex situations may reflect less optimistic and more uncertain language by the BoE due to the complexity of the situation. Summarily, as an inflation-targeting central bank is required to explain significant deviations of its policy actions from its inflation target, the bank may be ‘less clear, less certain and less optimistic’ in its communications when macroeconomic environments are unfavourable. If we assume that the above hypothesis holds and that central banks indeed respond to complex macroeconomic conditions with more complex communication, another perspective we explore is that for the BoE to be perceived as transparent, their communication should reflect the current complex state of the macroeconomy. Therefore, the bank will communicate with more complexity, less optimism and more uncertainty where prevailing inflation is further away from its target and exchange rate pressures are causing the depreciation of the local currency.

Given that the BoE’s projections via their MPC minutes and Inflation reports are mainly based on current macroeconomic data, we used current (time t) data for our inflation and exchange rate variables. However, there is the question of what the MPC already knew at the time of deliberation and of writing the MPC minutes. We assumed that at the point of meeting, past and current period macroeconomic data were available for the MPC to scrutinise. We therefore expected the decision-making process to follow figure 4.1 below.

Figure 4.1: *A stylised model of the UK monetary policy decision-making process*



Our work is mainly concerned with how activities and conditions in t_I above go on to impact C_I through the intermediate activities in between these two points. As conditions in t_I change, deliberations and interest rate decisions need to be carried out and the outcome of this is reflected in C_I . In summary, this section of our work therefore simply explores the association between t_I and C_I and tests whether the activities between the communication cycle have any impact on C_I .

4.5 Tests for model misspecification

To test that our model above was correctly specified and did not neglect any important non-linearities, we carried out Ramsey's (1969) regression specification error (RESET) test. The basic assumption of the RESET test is that an expanded model can be written in an alternative and more functional form by taking powers either of the fitted response of the independent variables or their first principal components. A standard F test is then carried out to determine if the additional variables included in the expanded model have any significant influence. Given that the inclusion of non-linear variables has the drawback of using up degrees of freedom if there are many explanatory variables in the model, the inclusion of non-linear forms has to be justified. Furthermore, as Wooldridge (2013) points out, the inclusion of quadratic and interaction variables will not necessarily detect certain kinds of neglected non-linearities.

If our specified model in equation 4.1 above satisfies the multiple linear regression assumptions, then non-linear functions of the independent variable from the estimated equation should be insignificant when added to the expanded model. Although there is no means of detecting how many functions of the fitted variables should be included in the expanded model when implementing the RESET test, we included the squared and cubed terms as this has been proven to be useful in most applications (Wooldridge, 2013).

Let \hat{C} denote the fitted OLS values derived from estimating equation 4.1 above. Our expanded RESET equation will take the form:

$$C_{it} = \alpha + \beta_{\pi}\pi_t + \beta_{\pi c}|\pi_t - \pi_t^*| + \beta_{\pi e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_{\gamma}\gamma_t + \beta_D DIR_t + \beta_{FC} FC_t + \delta_1 \hat{C}^2 + \delta_2 \hat{C}^3 + \varepsilon_{it} \quad \dots(4.4)$$

Our null hypothesis for testing if equation 4.1 is missing non-linear variables is that the equation is correctly specified. Thus, the RESET test is the F statistic $H_0: \delta_1 = 0, \delta_2 = 0$ in the expanded model 4.4 above. A significant F test will signify some sort of functional form problem. The results of our RESET tests are presented along with the results from the respective regression equations below.

4.6 Results

4.6.1 OLS regression results for MPC minutes

Table 3.1 below shows a summary of the results from our analysis of the impact of the macroeconomic variables of interest on the complexity and the tone of MPC minutes. All three models below were tested for model misspecification using Ramsey's RESET test and we found no evidence that our models were missing any non-linear and interaction terms. Our results below show that, at least at the 1% significance level, in no case was the null hypothesis of correct specification of the linear model rejected. Thus, there was no evidence of functional form misspecification in our models below.

Table 4.1: Impact of macroeconomic variables on complexity and tone of MPC minutes

	Model 1 (Complexity of communication)	Model 2: (Tone of communication)	Model 3: (Tone of communication)
	<i>Dependent variable - Flesch-Kincaid Grade Level</i>	<i>Dependent variable - Optimism</i>	<i>Dependent variable - Certainty</i>
<i>Constant</i>	8.90697*** (3.14196)	57.7254*** (3.83727)	53.6617*** (7.91481)
<i>Current inflation rate</i>	0.0686916** (0.0328973)	−0.0794143** (0.0381931)	−0.0659490 (0.0789395)
<i>Contemporaneous inflation gap</i>	0.0369135 (0.0981066)	−0.371871** (0.186121)	−0.0654023 (0.315897)
<i>Forward-looking inflation gap</i>	−5.06693 (3.32684)	12.1695** (5.67179)	0.793871 (10.8741)
<i>Exchange rate</i>	−1.26990** (0.516608)	−0.375111 (0.672698)	1.65307 (1.19256)
<i>Inflation report dummy</i>	0.221404** (0.101807)	-	-
<i>Financial crisis</i>	−0.363707 (0.262423)	−0.475544 (0.299756)	−1.07565** (0.450863)
<i>Time trend</i>	−0.0135759** (0.00734345)	0.0206472 0.00848562	0.0123470 (0.0170938)
<i>SE of regression</i>	0.746521	1.202722	2.263324
<i>R squared</i>	0.263595	0.15327	0.139343
<i>Durbin Watson</i>	1.565484	1.506351	1.893791
<i>RESET test for model specification</i>			
Test statistic	F (2,205) = 1.00929	F(2, 206) = 1.39542	F(2, 206) = 2.19472
P-value	P (F (2,205) > 1.00929) = 0.366282	P(F(2, 206) > 1.39542) = 0.25006	P(F(2, 206) > 2.19472) = 0.113988

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis⁵

⁵ Our Durbin Watson test results show the possibility of serial correlation within our macroeconomic data set, therefore the HAC standard errors (Bartlett kernel) were used to accommodate for potential serial correlation problems (see Muller 2014 for a recent review).

In Model 1 we considered the effect of the complexity of communication on the inflationary and exchange rate variables of interest. We also explored the role that the existence of a financial crisis and the release of inflation reports play in shaping the complexity of communication. Finally, we explored whether there was a significant trend in the complexity of communication over our sample period. In line with our first research question, we found statistically significant evidence that the complexity of communication over our sample period reduced by a small amount. The evidence suggests that the documents became clearer by requiring 0.01 less years of education to comprehend them. Our result therefore suggests that we can reject the null hypothesis that there is no change in the trend of complexity of central bank communication over time. Although quite unsubstantial, the evidence is in line with the notion within the linguistic literature that public documents have become clearer over the past century (see DuBay 2004). By putting out communication that has become increasingly clearer, this finding also supports the evidence in the literature that suggests that the BoE is increasingly becoming transparent and accountable (e.g. see Fracasso et al. 2003; Eijffinger and Geraats 2006; Dincer and Eichengreen 2007).

We also find significant evidence that suggests that the current inflation growth rate and the exchange rate have an impact on the complexity of the BoE's communication. On the basis of the foregoing, we therefore rejected our null hypothesis that there is no association between the complexity of communication and the macroeconomic environment in which the communication is made. Our results suggest that as current inflation rate rises, the complexity of MPC minutes rises as well. In the same vein, as the value of sterling relative to the USD falls, complexity of communication rises. We found the effects of exchange rate pressures on communication to be twice that of the current inflation rate. These results also support our hypothesis that complex macroeconomic conditions, depicted by rising inflation rates and depreciating sterling, have driven complexity in communication put out in the form of MPC minutes. If we assume the BoE to be following the hypothesised behaviour of reflecting the true macroeconomic conditions in which the communication is made, it can be inferred that the bank is exhibiting transparent behaviour in its MPC communication.

Finally, on communication complexity, we found evidence that in a month where inflation reports were released alongside the MPC minutes, this tended to increase the complexity of information released in the MPC minutes. The reason for this may be linked to the fact that the existence of an inflation report in the current month means there was more information for the MPC to scrutinise and hence the need to put out potentially more complex

information. Of significant interest is the role that the financial crisis played in the complexity of communication; the evidence suggests that the financial crisis had no impact on the complexity of MPC communication.

Next, we evaluate the results on the impact of macroeconomic condition on the tone of central bank communication with particular focus on the level of optimism and uncertainty reflected in the MPC minutes. Our results suggest that as inflation rises and as the contemporaneous inflation gap widens (i.e. inflation moves further away from the inflation target), MPC communication becomes less optimistic. However, we find that as the forward-looking inflation gap widens, MPC communication becomes more optimistic. Given that only our inflation variables were significant in this model, it can be assumed that optimism in MPC communication is only impacted by inflationary pressures. Our results on the effect of inflationary pressures on the optimism of communication suggest that current inflationary pressures in the form of rising inflation and widening contemporaneous inflation gaps were the main drivers of reduced optimism in MPC communication whilst future inflationary pressures had the effect of increasing optimism.

Finally, our results show that individual macroeconomic variables have no impact on the uncertainty of MPC communication, however, the presence of a financial crisis does. We found evidence that suggested that the 2008 financial crises had the effect of reducing the uncertainty of MPC communication by as much as one year of education. Given the foregoing, we can reject the null hypothesis that there is no association between the tone of MPC communication and the macroeconomic condition in which the communication is made. We should note, however, that this can be argued to be somewhat inaccurate when we consider the tone of uncertainty in communication as there seemed to be no association between individual inflationary and exchange rate variables. Nonetheless, the financial crises did have an impact on the uncertainty of communication.

In summary, our result in this section suggests that there is an association between the complexity and tone of MPC communication and the macroeconomic condition in which these are made. Specifically, we found evidence that rising inflation tended to increase complexity and reduce optimism whilst a widening of the contemporary inflation gap also reduced optimism. There was also evidence that falling exchange rates increased the complexity of communication and the presence of the 2018 financial crisis may have increased uncertainty as well. Put together, the evidence from this section of our work lends some support to the notion that more complex macroeconomic conditions, evidenced by rising inflation, widening contemporary inflation gap, falling exchange rate and the presence of a financial crisis may

have caused the BoE to communicate with more complexity, less optimistic and in a less certain manner.

4.6.2 Results of the impacts of the macroeconomic environment on the complexity and tone of inflation reports

Our next set of analyses explores the impact of macroeconomic conditions on the complexity and tone of inflation reports. Here, we tested the same sets of hypotheses as those above for MPC minutes. Our first hypothesis was to test whether the complexity and tone of inflation reports changed over our sample period, whilst the second hypothesis tested whether there was an association between the complexity and tone of inflation reports and the macroeconomic conditions in which they were made. Similar to the models above, we tested for model misspecification using Ramsey's RESET. Our results again showed that, at the 1% significance level, in no case was the null hypothesis of correct specification of the linear model rejected. Thus, there was no evidence of functional form misspecification in our models below. A summary of our results is shown in table 4.2 below.

Table 4.2: Impact of macroeconomic variables on Complexity and Tone of Inflation Reports

	Model 1 (Complexity of communication)	Model 2: (Tone of communication)	Model 3: (Tone of communication)
	<i>Dependent variable - Flesch-Kincaid Grade Level</i>	<i>Dependent variable - Optimism</i>	<i>Dependent variable - Certainty</i>
<i>Constant</i>	15.6558*** (0.953754)	55.8062*** (7.78519)	62.4856*** (10.9649)
<i>Current inflation rate</i>	1.6853* (0.9.7558)	−0.0588061 (0.0767495)	−0.214557* (0.115888)
<i>Contemporaneous inflation gap</i>	−0.409806* (0.214253)	−0.479710*** (0.149974)	−0.954528* (0.530692)
<i>Forward-looking inflation gap</i>	5.48568 (4.81625)	15.7276* (8.92200)	29.8376 (28.0536)
<i>Exchange rate</i>	−2.57431*** (0.570118)	−0.427876 (1.12654)	−3.01280* (1.78514)
<i>Financial crisis</i>	0.239575 (0.144431)	−0.0772009 (0.359366)	−0.506390 (0.688619)
<i>Time trend</i>	0.0153420 (0.00937533)	0.0557999 (0.0516352)	0.161739** (0.0807289)
<i>SE of regression</i>	0.647455	1.212872	2.336178
<i>R squared</i>	0.325217	0.065501	0.065927
<i>Durbin Watson</i>	1.438758	1.747468	1.877011
<i>RESET test for model specification</i>			
Test statistic	F (2,62) = 1.834561	F(2, 62) = 1.31398	F(2, 62) = 1.3148
P-value	P(F(2,62) > 1.83456) = 0.168	P(F(2, 62) > 1.31398) = 0.276128	P(F(2, 62) > 1.3148) = 0.27591

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis

When we explored whether the trend of the complexity and tone of inflation reports changed over our sample period, we found evidence that suggested that the complexity and optimism in communication did not follow a significant trend, however, the level of certainty portrayed in the inflation reports increased over the sample period. Similar to MPC minutes,

we also found consistent evidence to suggest that rising inflation rate and a depreciating sterling tended to drive up complexity in the manner in which inflation reports were written. Here, we rejected the null that there is no association between the complexity of inflation reports and the macroeconomic conditions in which the communication is made. In fact, these results provide further evidence for the idea that difficult macroeconomic conditions, evidenced by rising inflation and depreciating sterling values, tend to make the BoE's policy communication (both MPC minutes and inflation reports) more complex.

In contrast to MPC minutes, we found consistent evidence that suggested that pressures from inflation targeting had a significant impact on both the tone and complexity of inflation reports. When the complexity of communication is considered, inflation moving towards the inflation target or otherwise impacted the complexity of inflation reports, albeit in an unusual manner. The evidence suggests that as inflation moves closer to the inflation target, there seems to be more complex information put out. This behaviour is divergent from our hypothesised behaviour that such inflationary pressures should drive up the complexity of communication. When we consider both the optimism and certainty with which the inflation reports communicate, however, we find behaviour consistent with our hypothesis. As inflation moves further away from the inflation target, we found that communication via inflation reports became less optimistic and more uncertain.

Finally, we consider our analysis of the uncertainty of inflation report communication in more detail. We found that inflation pressures both from the current inflation rate and the divergence from the inflation target led to an increased level of uncertainty in the manner in which the inflation reports were written. Interestingly, however, we found evidence that depreciating sterling led to an increased level of certainty in the inflation reports. Put together, these results may suggest that the BoE is not necessarily motivated to communicate in a more complex manner by depreciating sterling as they are with rising inflation. There is some intuition to this finding as cheaper sterling has significant benefits for trade and capital inflows, and inflation reports focus significantly on these areas of the economy in their analysis.

There is some support for our findings on uncertainty in the central banking literature that may help explain our results. According to Gruner (2002), central banks being uncertain in their behaviour may indeed be an optimal strategy by the bank as they argue that more uncertainty about the objectives of the central bank leads to more wage discipline and subsequently lowers wage inflation (see Rose 1991). This argument holds in so far as uncertainty from the central bank's communication affects trade union behaviour.

4.7 Conclusion

This chapter explored the time-varying characteristics of the complexity and tone of the Bank of England's communication as well as the role that macroeconomic conditions play in determining the complexity and tone of the BoE's communication. This chapter is central to our fundamental research questions, which seek to explore variability of complexity and tone and how these are driven by macroeconomic conditions in which these communications are made. Our analysis focused on communication in the form of MPC minutes and inflation reports. We used computer-aided textual analysis to derive quantitative values for communication complexity, optimism tone and uncertainty tone. Our macroeconomic data mainly included variables that captured inflationary pressures and exchange rate pressures, namely, inflation rate, the contemporaneous inflation gap, the forward-looking (ex-ante) inflation gap and exchange rate. We further included the financial crisis dummy variable to control for the important period of the 2008 financial crisis. We then expressed our macroeconomic variables as a function of each of these dimensions of communication. Our null hypothesis which we sought to test in these models was (i) that there was no noticeable trend in the complexity and tone (optimism and uncertainty) of communication over our sample period and (ii) that there was no association between the complexity and tone of communication and the macroeconomic variables which we used in our model.

In line with our first hypothesis, we found evidence that the complexity of MPC minutes published by the bank decreased over our sample period. By implying that clarity is an important precondition to transparency, this finding is in line with recent suggestions in the literature that central banks employ every means they can to increase transparency. We did not, however, find similar evidence in terms of a decrease in complexity of inflation reports as our trend variable turns out insignificant. When we explored the tone of communication, we found evidence that the level of uncertainty reflected in the BoE's inflation reports also reduced, signifying that the Bank had grown more assured in its inflation report communications. We did not find evidence of any other trends in the tone of communication reflected in the bank's inflation reports.

We subsequently tested our second hypothesis as to whether there was any association between the communication made and the macroeconomic conditions at the time of making the communication. We found significant evidence to show that macroeconomic conditions had a sizeable impact on the complexity and tone of the BoE's communication. Our core finding in this chapter is that when the BoE is faced with what we define as a difficult macroeconomic condition, where inflation is rising and the value of the sterling is falling, the

complexity of both MPC minutes and inflation reports tends to rise significantly. We found that falling sterling values tended to impact complexity of communication the most, with MPC minutes requiring a further 1.3 years of formal education to comprehend the text and inflation reports requiring 2.5 years of formal education for every unit 10p fall in value of the sterling.

Generally, inflationary pressures seemed to be a dominant driver of complexity and tone across both MPC minutes and inflation reports. A rising inflation rate was observed to reduce optimism in MPC minutes and increase uncertainty in inflation reports. Furthermore, we found consistent evidence that as inflation deviated further from the inflation target both MPC minutes and inflation reports were significantly less optimistic. Somewhat surprising, however, when we explore the forward-looking inflation gap – i.e. the difference between current inflation and the inflation forecast for four quarters ahead – a widening of the gap seemed to drive up optimism in both MPC minutes and inflation reports. This particular finding suggests that the BoE is more optimistic when future inflation is high but less optimistic when current inflation is high. This makes intuitive sense; a rising inflation forecast may be evidence of future economic growth and increased output, and as such the BoE is reflecting its anticipation for the future growth in its current communication.

Given that we hypothesised that a transparent central bank may communicate with more complexity, less optimism and more uncertainty if it is indeed faced with a scenario that is more complex, these findings may also support the notion that the BoE exhibits elements of transparency through its behaviour. Although rising inflation and falling sterling values may be considered difficult macroeconomic conditions, it is important to explore more complex scenarios such as the existence of a financial crisis. Of particular note, therefore, is the role that a financial crisis plays influencing the complexity and tone of communication. In doing this, we found evidence that the 2008 financial crisis significantly increased the level of uncertainty observed in MPC minutes but there seemed to be no impact on other measures of complexity and tone across MPC minutes and inflation reports. This suggests that the complexity and tone of communication is more impacted by changing inflationary and exchange rate environments than by a full-blown financial crisis.

Overall, our findings provide very useful information for central banks in helping them understand what drives the clarity and tone with which they make policy communication. Although the manner in which central banks often communicate in response to the macroeconomic conditions may be unintentional on the part of the banks, the evidence suggests that their communications are significantly influenced by the macroeconomic conditions prevailing at the time of the communication. Therefore, our findings have significant policy

implications for central banks in that they can consciously adjust the clarity and tone of communication ex-ante, in response to the existing macroeconomic conditions. For instance, particular emphasis can be placed on improving clarity by reducing the complexity of texts used in communications where there are economic environments with rising inflation and falling sterling values. In many cases, in such difficult conditions, the bank itself may be unclear as to how to communicate; however, by eliminating the tendency to communicate with increased complexity, and by using more clearly written language, communication will be more transparent. Being aware of the tendency for communication to be unclear in such periods as our evidence suggests will indeed help banks to improve their transparency practices.

CHAPTER FIVE

5.0 EVALUATING SHOCK TRANSMISSION FROM CENTRAL BANK COMMUNICATION TO THE MACROECONOMIC ENVIRONMENT

5.1 Introduction

To further explore the nature of the relationship between central bank communication and our economic and financial variables of interest, we carried out a series of analyses that sought to analyse the onward effects of the Bank of England's communication on the macroeconomic and financial environment. This chapter seeks to address our research question on whether the release of the BoE's MPC minutes transmits shocks to key macroeconomic and financial variables when they are made. Here, we focused on whether the dimensions of central bank communication that we explore have an impact on key macroeconomic and financial variables in a way that is similar to traditional monetary policy tools such as the policy rate. Therefore, we only analysed monetary policy communication via MPC minutes as these contain policy communication which inflation reports do not contain, and also, we only explored the complexity and optimism reflected in the communication.

The chapter uses a more traditional approach in evaluating the role of communication in monetary policy. Under a traditional view of monetary policy, central banks control nominal interest rates at very short horizons and as such, economic agents take a view of impending developments. By doing this, economic agents are able to form their own long-term view of the central bank's policy stance. The Taylor (1999) rule has been regarded as a useful monetary policy rule that helps explain the path of such monetary policy behaviour, especially in terms of the Federal Reserve. In fact, whilst exploring US monetary policy history, Taylor (1999) argued that the rule largely reflected US monetary policy at the time when it was deemed to be relatively successful in driving the economy. He therefore proposed the rule as a principle for behaviour for policy makers.

To put this in context, let us assume a central bank that follows a simple rule of nominal interest rate in the spirit of Taylor, e.g. as highlighted by Hansen and McMahon (2016) below:

$$i_t = \phi' \theta_t + \varepsilon_t \quad \dots (5.1)$$

Where i_t represents the bank's current stance of the economy at time t which is often depicted by the official base rate;

\emptyset captures a vector of reaction coefficients;

ϑ_t captures economic inputs into the rule at time t , which are also inputs used by central banks in their decision making as well as to derive their outlook on current and expected economic stance; and,

ε_t captures the bank's expected deviation from this average rule at time t , also partially represented by the bank's certainty in following a path that may deviate from the average rule.

The intuition we follow is that when a central bank communicates in an inflation-targeting environment, it discloses i_t , and economic agents can thereafter make a decision that informs their belief on the future path of interest rate i_t based on their expectations of the inputs (ϑ_t) to the rule. In a zero lower bound environment, however, i_t may become redundant as the central bank may be unable to reduce this further in response to a policy requirement. Such a scenario therefore necessitates the need for a variable that can be used to manage short-term policy expectations within a Taylor rule framework, similar to what the International Shadow Short Rates developed by Krippner (2015) seeks to achieve.

A number of works have been done on evaluating the extent to which central bank communication adds information to the standard Taylor rule which uses inflation and output growth to forecast upcoming interest rate decisions. Using backward-looking Taylor rule models, Heinemann and Ullrich (2007), as well as Rosa and Verga (2007), found that communication does improve the fit of the standard Taylor rule when communication variables are included. However, given that interest rate changes affect inflation and output with a significant lag, monetary policy should be forward looking. Indeed, studies such as Gorter et al. (2008) have found that in backward-looking Taylor models, the Taylor principles do not hold. Other studies such as Sturm and De Haan al (2011) have argued for the use of a forward-looking Taylor model to be able to significantly capture the effects of communication within the rule. They found that the inclusion of a communication variable into the standard Taylor rule adds information that helps predict the future path of policy decision by the ECB.

In this study, we explored two dimensions of communication, namely the complexity and optimism in the Bank of England's communication as inputs to the simple rule defined above. Similar to our previous analyses, we use the Flesch-Kincaid readability scores as a measure of complexity and the Diction software programme to obtain quantitative values for 'optimism'. It is important to note that we only focused on complexity and optimism because we argue that these dimensions of communication contain vital policy intentions by central banks that help drive expectations, as in i_t in a standard Taylor rule. For instance, from a monetary policy standpoint, a rise in optimism in communication at a point when markets are

recovering may signal a rise in rates in the near future and may also have the same policy effect as an actual rise in rates. The opposite is even more applicable in a zero lower band environment, given that there is no accommodation for further reduction in rates. In the same way, the central bank may use clarity or otherwise in its policy intention to control market expectations, as indeed Alan Greenspan was noted to do with his ambiguous policy remarks.

Consistent with our previous analyses, we explored communication in the form of monetary policy committee (MPC) minutes. Here, we ignored inflation reports as we focused mainly on monthly policy communications, as we suggest that these provide a more regular outlet for the bank to drive policy. In analysing the effects of these policy communications on the economic and financial variables of interest, we followed the seminal work of Bernanke, Boivin, and Elias (2005) which used a factor augmented vector autoregression (FAVAR) methodology in assessing the effects of central bank communication. This approach is also comparable to Hansen and McMahon (2016), who similarly explored three dimensions of FOMC communication using textual analysis in examining the role of monetary policy on economic and financial variables. However, rather than focusing on the Fed, we focus on the BoE, and also on the complexity and optimism of MPC communication using computational dictionary methods rather than topic modelling.

In general, VAR models use a multivariate methodology in which changes in each of the variables are linked to changes in its own lags as well as changes in other variables and the lags of these other variables. VAR models have been used extensively in the empirical analysis of monetary policy issues (see Bagliano and Favero 1998 for a survey). Where there exists no clear specification of a structural model to evaluate certain macroeconomic issues, VAR models become very useful in identifying relationships between variables. As is the case in this study, despite extensive evidence that central bank communication impacts financial and economic variables, it cannot be said for sure what the direction of these impacts will be if the complexity or optimism of the bank's communication varies.

Although the standard structural VAR approach delivers a substantial amount of structural information when used to measure the effects of monetary policy shocks, there are significant limitations to using the approach. Notably, as Christiano et al. (1999) highlight, a number of researchers have disagreed on the appropriate strategy for identifying policy shocks as alternative identifications can lead to varying results. Additionally, Bernanke et al. (1997) suggest that the standard VAR methodology ignores the arguably more important effects of the monetary policy rule and focuses mainly on the unanticipated changes in monetary policy.

These limitations often revolve around the idea that the standard VAR methodology uses a relatively small amount of information to identify monetary policy.

As Bernanke et al. (2005) highlight, most standard VAR methodologies employ about six to eight variables which are in reality unlikely to span the information set used by central banks in their decision making. Typically, central banks will explore a wide range of information and in the case of the Bank of England, this even extends far beyond the information provided by bank staff and includes information from independent reports as well. Bernanke et al. identify that the effect of estimating a standard VAR in such a scenario with a limited information set is that: (i) the measurement of policy innovations is likely to be contaminated, e.g. as in the price puzzle by Sims (1992); (ii) unobserved components of observable measures may not be captured, e.g. through measurement errors and; (iii) only impulse responses for included variables, which may be only a portion of the relevant variables, can be observed. For instance, one might look to capture the theoretical concepts of ‘economic activity’ using standard GDP or industrial production measures but there may be unobserved components of these data sets that do not wholly capture economic activity. Within a FAVAR model, however, one is able to capture the effects of wider variables, such as retail sales and employment statistics, within a wider assessment of economic activity. It is important to note that simply including additional variables in a standard VAR methodology will severely limit the model due to the degrees of freedom problem.

It is in the context of these limitations to the standard structural VAR methodology that Bernanke (2005) explored the FAVAR models. Hansen and McMahon (2016), using the FAVAR methodology, suggest that the approach allows the inclusion and observation of a large number of variables without running into the curse of dimensionality. In simple terms, the FAVAR approach is a dynamic factor model that summarises the information from a large set of time series data by using relatively small sets of estimated indices or factors. The idea of a FAVAR is based on the original works of Stock and Watson (2002), which developed a dynamic factor model to summarise the information in large data sets using a smaller set of data. Given the context of our analysis, where we simply explore a couple of dimensions of the BoE’s communication in a bid to explain the bank’s entire policy stance, this model becomes eminently appropriate.

5.2 Methodology: FAVAR framework

In this study we generally follow Bernanke et al.'s (2005) specification of the FAVAR model, which uses a two-step principal component approach to identify the unobserved factors. The model contains three main dimensions, which are the observed factors, the unobserved factors and the observed economic time series.

Suppose Y_t is an $M \times 1$ vector of variables that are assumed to drive the economy and are observable. Y_t could contain information relating to a policy variable (e.g. communication or short-term interest rate) or other observable measures of real activity and prices that qualify. In a standard VAR or structural VAR methodology, Y_t in itself will be touted as the main variable driving the economy; however, Y_t data may not fully capture additional economic dimensions relevant to modelling the dynamics of macroeconomic policy. Within the FAVAR framework, these additional economic dimensions that are unobserved may be captured by a $K \times 1$ vector of unobserved factors F_t , where K is 'small'. In our model, F_t may be assumed to capture the several other dimensions of communication that we do not explore, are not captured by measurement errors or that are perceived by economic agents in a different way.

The structure of the dynamics between these two factors is given by:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + v_t \quad \dots (5.1)$$

The above equation is a standard VAR in (F_t', Y_t') and could be estimated if we had observable values for F_t ; however, in this case, values of F_t are unobservable. Suppose, however, that we have a series of informational time series of economic variables denoted by a $N \times 1$ vector of X_t . The assumption here is that N is greater than the time periods T and is also assumed to be greater than the number of factors and observed variables in the FAVAR framework. The informational time series X_t can be expressed as a function of the unobservable factors F_t as well as the observable factors Y_t in the form below:

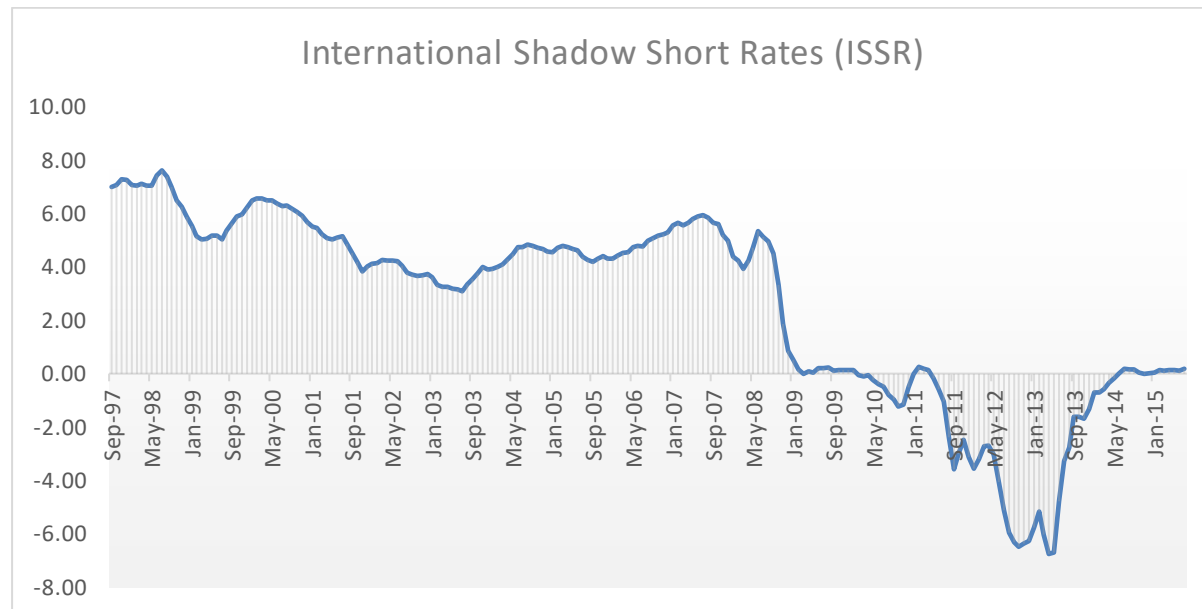
$$X_t = \Lambda^f F_t + \Lambda^y Y_t + \varepsilon_t \quad \dots (5.2)$$

In keeping with Hansen and McMahon (2016), equation 5.2 above is referred to as the 'observation equation' while equation 5.1 is the 'transition equation'.

The original baseline FAVAR model by Bernanke (2005) uses only one dimension, the Federal Funds rate, as the driving variable affecting the economy (i.e. $Y_t = i_t$ and a single

factor therefore $K=1$). We primarily propose three dimensions of monetary policy drivers, namely, the complexity of communication, the optimism of communication and the policy rate variable, as our policy tools and extract four factors ($K = 4$) to be used in our FAVAR analysis. The introduction of a policy rate variable is important to our analysis as it helps us capture the fundamental effects that an implied policy rate has on the macroeconomy and as such we can control for the bank's intended policy actions. However, a problem arises given that our analysis contains the period 2009 to 2015 where interest rates were at the zero lower band (ZLB) and as such the bank could not realistically cut interest rates lower in response to economic conditions. Using the interest rate as a policy rate variable may therefore have the effect of understating the effects of the bank's policy making during this period. To alleviate this problem, rather than rely on the interest rate variable, we use the international shadow short rates (ISSR) developed by Krippner (2015), which was constructed using a lower bound framework with two factors and reflects the current stance of monetary policy at the lower bound. The ISSR is the actual policy rate above the ZLB but also has the advantage of going into negative territory when the policy rate hits the ZLB, as seen in figure 5.1 below.

Figure 5.1: International shadow short rates developed by Krippner (2015)



Our multidimensional monetary policy FAVAR is therefore expressed as below:

$$Y_t = \begin{bmatrix} Comp_t \\ Opt_t \\ ISSR_t \end{bmatrix} \quad \dots (5.3)$$

Where $Comp_t$ denotes the complexity of MPC minutes, Opt_t denotes the optimism tone of MPC minutes and ISSR is the international shadow short rate. To estimate our FAVAR, we follow the original two-step principal component approach by Stock and Watson (2002) and cited in Bernanke et al. (2005). The approach involves first estimating the factors using principal components - F_t , and then estimate VAR in F_t and Y_t .

5.2.1 Estimating principal components

In the first step, the approach estimates $K + M$ principal components of X_t which is referred to as $\hat{C}(F_t, Y_t)$ and are linear combinations of F_t and Y_t . This indicates that the number of factors (K) are added to the number of Y_t variables. Bernanke and Boivin (2003) highlight that a useful implication of this step is that it allows researchers to deal with data irregularities in a systematic way, without necessarily obtaining spurious results. They analyse X_t in a number of scenarios where the data include monthly and quarterly series as well as series with missing values or that have been discontinued. As Hansen and McMahon (2016) point out, this process is aimed at identifying the structural shocks to all of the Y_t variables but this cannot be done if estimated factors include the effects of Y_t . Therefore, the effects of the Y_t variables we are interested in shocking will need to be eliminated from $\hat{C}(F_t, Y_t)$.

We followed the identification assumptions proposed by Bernanke et al. (2005) and which have been used extensively in FAVAR models (e.g. see Mumtaz and Surico, 2007; Baumeister et al., 2010; and Wu and Xia, 2016). Under the first identification assumption, two categories of information variables are identified, namely, slow-moving variables and fast-moving variables. Slow-moving variables are often identified as those variables that do not respond contemporaneously to unanticipated changes in monetary policy (policy shocks). As in our previous analysis, some of our macroeconomic variables of interest only include GDP growth rate, inflation rate, the pound/dollar exchange rate and the FTSE 100 growth rate, which effectively capture key aspects that are communicated by the BoE in MPC minutes and inflation reports. In our FAVAR specification, however, we are able to include dozens of macroeconomic and financial market variables in our analysis. Put together, our analysis

employs up to 71 variables and details of these are shown in our appendix. Variables such as GDP growth rate, industrial production, Retail price index etc are identified as slow-moving variables that feed into our FAVAR model. Fast-moving variables, on the other hand, are those variables that will respond contemporaneously to policy shocks. Variables such as our stock market return, bond yields and the exchange rate variables are considered to be fast-moving variables that feed into our FAVAR model.

Next, our approach involved estimating the principal components of the slow-moving X_t variables identified above. It is important to note that in the identification assumption above, Y_t does not react to these principal components. Given this, $\hat{C}(F_t, Y_t)$ can be identified as below:

$$\hat{C}(F_t, Y_t) = \beta_c \hat{C}^*(F_t) + \beta_y Y_t + \eta_t \quad \dots (5.4)$$

Equation 5.4 above is therefore estimated using standard OLS with principal components as regressors. Subsequently, F_t can be defined as:

$$\hat{F}_t = \hat{C}(F_t, Y_t) - \beta_y Y_t \quad \dots (5.5)$$

A potential problem of the above approach is that the factors we extract could be subject to sampling errors, therefore equation 5.2 above may be spuriously estimated (see Koop and Korobilis 2010 for details). Nonetheless, as with previous research using the two-step approach, we proceeded with this methodology while carefully identifying this caveat. The next section details the second step of our FAVAR model using a standard VAR methodology that incorporates the factors estimated in this section.

5.2.2 Standard unrestricted VAR

The second step of the two-step FAVAR approach involves estimating a standard VAR in F_t and Y_t of the form:

$$Z_t = \begin{bmatrix} \hat{F}_t \\ X_t \\ Y_t \end{bmatrix} \quad \dots (5.6)$$

With the reduced form being:

$$Z_t = AZ_{t-1} + v_t \quad \dots (5.7)$$

Although the standard VAR has been widely used in the traditional monetary policy literature to analyse the effects of macroeconomic policy shock (see Bagliano and Favero 1998 for a review), the limitations of the methodology have been well discussed above. Our inclusion of \hat{F}_t in the standard VAR helps significantly improve the information content of our standard VAR model. The idea behind the standard unrestricted VAR model is quite simple and has the advantage of avoiding the need to specify a structural model for the economy. The basic idea is that the impact of monetary policy in a standard VAR is defined by the structural model below:

$$A \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = C(L) \begin{pmatrix} X_{t-1} \\ Y_{t-1} \end{pmatrix} + B \begin{pmatrix} v_t^X \\ v_t^Y \end{pmatrix} \quad \dots (5.8)$$

Where X_t represents a vector of macroeconomic (non-policy) variables such as those highlighted in our list of 71 macroeconomic variables (X_t) that we specify in the appendix; and Y_t represents the policy variables controlled by policy makers, such as interest rate, and which in our case are the dimensions of policy communication we explore (i.e. complexity and optimism) and the ISSR.

Matrix A represents the contemporaneous relationship between the variables. C(L) is a matrix finite-order lag polynomial, while v is a vector of structural disturbances to the X_t and Y_t variables. In standard VAR models, the policy variables are assumed to be endogenous and therefore accommodate for the weakness of structural models where policy variables are assumed to be exogenous and as a result render the model invalid if monetary policy reacts endogenously to the macroeconomic variables. The main advantage of such a model as highlighted above is that the transmission mechanism is estimated to provide empirical evidence about the response of macroeconomic variables to monetary policy impulses rather than describe theoretical monetary policy.

The empirical starting point for analysing the standard VAR model is the estimation of the reduced form of the structural model (5.8) above in the form:

$$\begin{pmatrix} X_t \\ Y_t \end{pmatrix} = A^{-1}C(L) \begin{pmatrix} X_{t-1} \\ Y_{t-1} \end{pmatrix} + B \begin{pmatrix} u_t^x \\ u_t^y \end{pmatrix} \quad \dots (5.9)$$

Where u represents the VAR residual factor. The relationship between u (the VAR residuals) and v (the structural disturbances in the equation (x) above) is given by:

$$A \begin{pmatrix} u_t^x \\ u_t^y \end{pmatrix} = B \begin{pmatrix} v_t^x \\ v_t^y \end{pmatrix} \quad \dots (5.10)$$

To identify the structural parameters within the reduced form model, some important restrictions need to be imposed on some elements of A and B. Bagliano and Favero (1998) summarise these restrictions as: “(i) assuming orthogonality of the structural disturbances; (ii) imposing that macroeconomic variables do not simultaneously react to monetary variables, while simultaneous feedback in the other direction is allowed; and (iii) imposing restrictions on the monetary block of the model reflecting the operational procedures implemented by the monetary policy maker” (p. 5). The baseline VAR models used in monetary policy analysis assume that policy variables react contemporaneously to non-policy variables whilst the reverse does not hold.

Our model follows a new strand of literature that identifies communication as a policy variable and seeks to evaluate the reaction of non-policy macroeconomic variables to these communication shocks. Traditionally, the VAR framework identifies a simple policy rule that proposes a solution to the endogeneity of the policy variable and focuses mainly on the deviations from that policy rule. Given that we have assumed that communication takes on the role of i_t (the policy variable) in our simple Taylor rule model described above in equation 5.0, our analysis allows us to explore the responses of macroeconomic variables that are not expected by the market. These communication shocks are vital in understanding monetary policy in the age of inflation targeting and forward guidance where communication is now being used as a policy tool.

As is common within the FAVAR literature, we followed the restrictions that translate to the ordering of variables as proposed by Bernanke et al. (2005). The impulse responses are estimated by means of a Cholesky factorisation with Y_t which captures the dimensions of communication in our model ordered last. We therefore assumed a recursive structure whereby all the factors entering into the VAR system respond with a lag to change in the dimensions of communication (Y_t). This implies that no further restrictions are required in our equation 5.7

above and the policy shocks from communication can simply be identified as in a standard VAR model. The Cholesky factorisation orthogonalises the residuals from our non-policy factors X_t in the identification of our impulse responses.

5.3 Estimation and data

To assess the impact of macroeconomic policy communication, we explored monthly monetary policy communication from minutes of the MPC meeting. Our rationale for selecting these communication avenues are well described in the introductory and literature review sections of our work. Our sample period extends from the point where the BoE attained independence in 1997, and therefore obtained a greater mandate for inflation targeting, up until 2015, when the bank overhauled its communication and transparency practices. Using the FAVAR methodology, we estimated the effects of 214 MPC minutes on 71 macroeconomic and financial variables all sourced from Bloomberg. Specifically, we explored variables covering inflation, the financial market, the currency market, output and other macroeconomic aggregates.⁶ Most of these variables were carefully selected on the basis that they either (i) formed part of the input data going into the MPC's decision-making process as identified in the minutes or (ii) were a part of the Bloomberg monthly economic data releases that are widely followed by market participants.

In addition to the above, one further motivation for selecting our X_t (macroeconomic) variable was to follow the broad range of data categories used by Bernanke et al. (2005) which include: (i) real output and income variables; (ii) employment and hours variables; (iii) consumption variables; (iv) housing and sales variables; (v) real inventories, orders and unfulfilled orders variables; (vi) stock price data; (vii) exchange rate data; (viii) interest rate data; (ix) money and credit quantities aggregate data; (x) price indices; (xi) average hourly earnings; and (xii) other miscellaneous data. We replicated all 12 categories of data for the United Kingdom and explored them from the period where the bank gained its independence in 1997 until 2015. We used a total of 71 macroeconomic variables in our FAVAR analysis; details of these as well as their descriptions can be found in the appendix.

As required by the FAVAR methodology, we identified the price level and output growth type variables as slow-moving variables as these do not react contemporaneously to policy changes. On the other hand, we identified the financial markets and currency market

⁶ A list of the variables used are available in the appendix.

type variables as fast-moving variables. Our data series were transformed as required using codes 1 to 5 (see appendix).

We estimated FAVAR in the EViews software programme. Similar to a number of studies, including Bernanke et al. (2005) and Hansen and McMahon (2016) which we followed closely, our analysis used seven lags, although using up to 13 lags did not significantly change our results. As with the aforementioned studies, these lags were selected arbitrarily rather than using standard information criteria for selecting lag length. The confidence intervals for the models were generated using a two-step bootstrap method with 1000 bootstrap replications. As described above, in the first step, we estimated the unobserved factors of our financial and microeconomic data using principal components, as per Bernanke et al. (2005). In the second step we used the estimated factors along with our communication variable of interest to estimate a standard structural VAR model. Our study uses four factors ($K = 4$) to estimate our standard VAR, and as with Bernanke et al. (2005), using three or five factors did not qualitatively change our results. Following on from their study, using four factors within our FAVAR model was assumed to be sufficient for our analysis given that they found that only one factor substantially increased the quality of the standard VAR model and even eliminated a considerable part of the price puzzle documented by Sims (1992).

Our policy variable (Y_t) explored the various dimensions of monetary policy communication that we propose to be drivers of the macroeconomic environment, namely complexity, optimism and the ISSR. Before proceeding with the FAVAR analysis, we explored the effect of the complexity and tone variables on the ISSR (the BoE's monetary policy stance) using impulse response functions (IRF). This analysis is essential for capturing any additional effects on the policy rate that complexity and tone of communication may have. As per the previous sections of our work, we again used the Flesch-Kincaid Grade Level (Kincaid et al. (1975) as our measure of complexity of communication. The measure is one of the traditional methods of determining the readability of financial disclosure documents and has been used to capture clarity of central bank communication in the past (e.g. see Loughran and MacDonald 2014; Jansen 2011b; Bulir et al. 2014; Jansen and Moessner 2016b). For tone of central bank communication, we explored the 'optimism' variable which was obtained the Diction software programme.

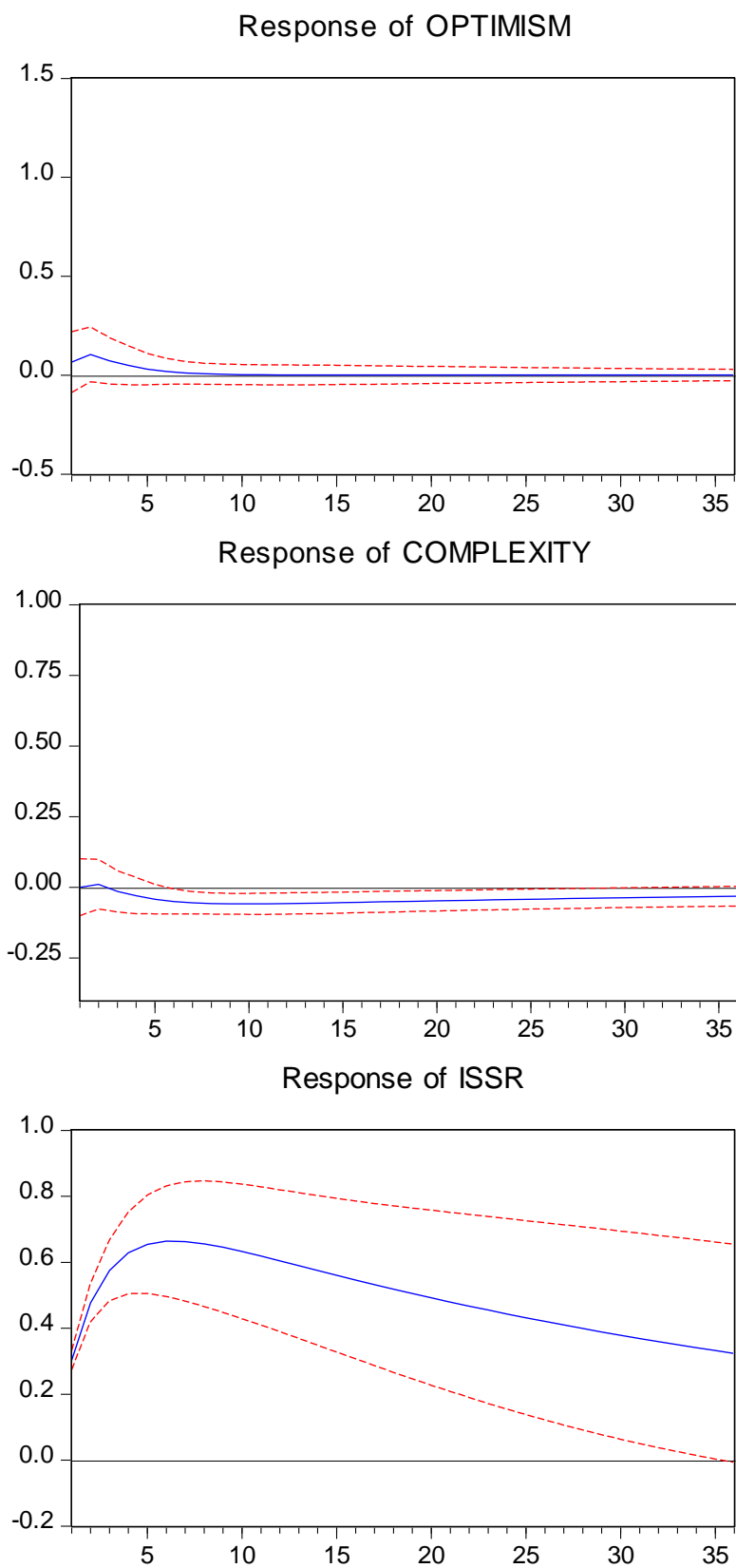
5.4 Results

As detailed in previous sections, our analysis explores the effects of two broad dimensions of central bank communication, namely complexity and optimism on both the macroeconomic environment and financial markets. We sought to explore the effects of shocks to these dimensions on the macroeconomic and financial variables analysed. Our analysis used a FAVAR methodology which allowed us to extensively explore the effects of these shocks on as many as 71 variables, thereby giving us a comprehensive view of the effects of communication shocks. The results from our analyses are detailed below.

5.4.1 The effects of a change in the policy rate (ISSR)

In the first instance, we explored the effects of a change in policy rate as measured by the international short shadow rate (ISSR) on the other communication variables. We then explored the effects of policy shocks from the ISSR on our financial and macroeconomic variables of interest. As highlighted above, the inclusion of a policy rate in our analysis of the effects of communication allowed us to capture both traditional monetary policy shocks and other policy shocks that may come from our communication variables. Figures 5.2 to 5.6 below show the impulse responses to the policy variable.

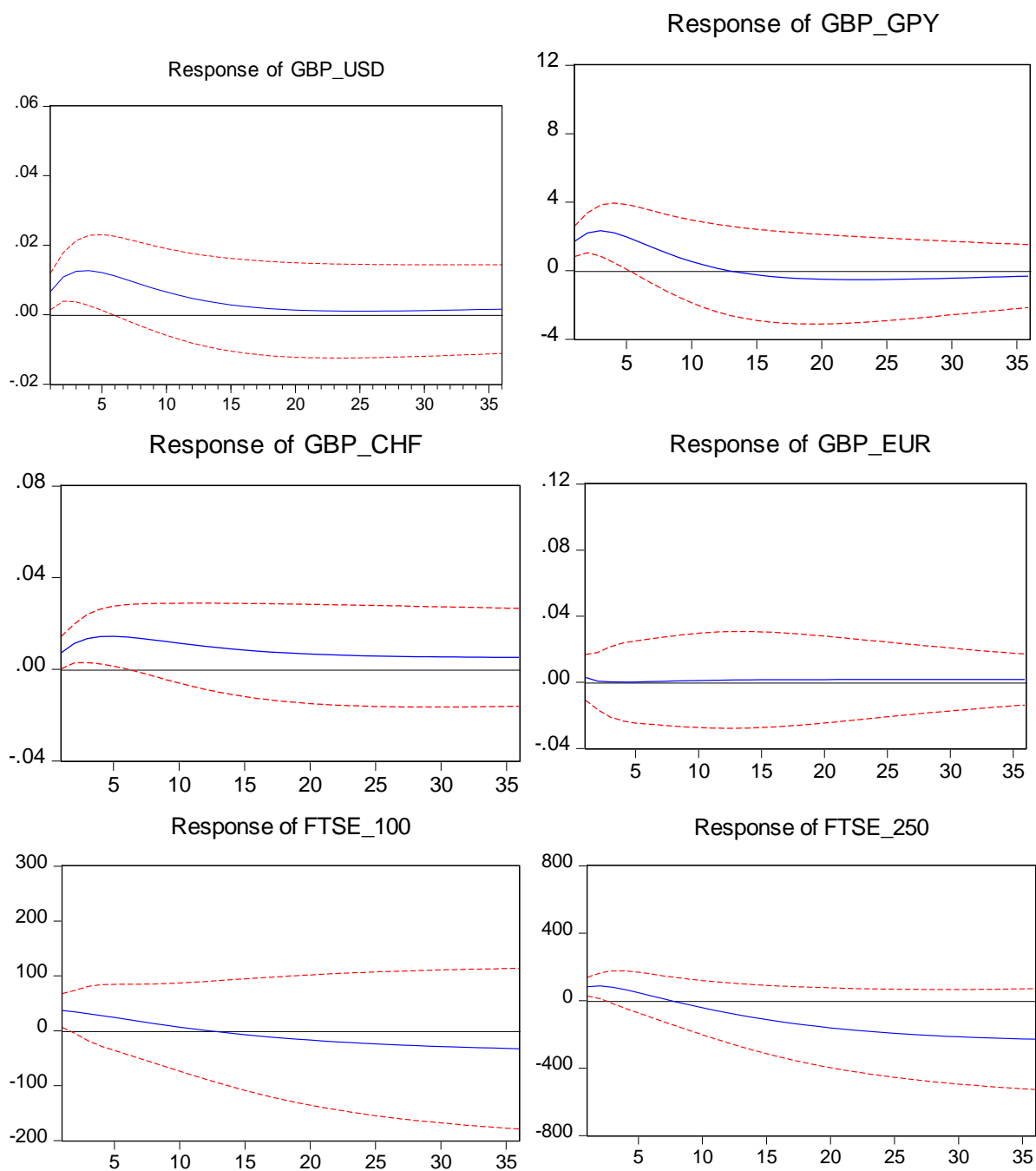
Figure 5.2: Impulse response of policy variables to policy rate (ISSR) shocks



The results suggest that shocks to the ISSR tend to drive down optimism and complexity over the short to medium term as shocks were not persistent beyond the six-month mark. The implication of this is that in figure 5.2, shocks to the policy rate drove down all the financial markets indices we explored (i.e. the FTSE 100, FTSE 250, FTSE 350 and the FTSE All Share), irrespective of the size of the constituent companies. The shocks here are persistent and the indices exhibit a steady decline towards negative territory. A combination of factors was highlighted to cause a decline in financial market indices following contractionary shocks to the policy rate. One dominant argument is that the cost of capital rises and thus makes investment difficult for investors and a second argument is the role that such shocks play in encouraging savings over investments. These two combined effects have the effect of putting downward pressure on the financial markets and are in line with the expectations of economic theory. These results are further consistent with several previous studies which have found that tightening of monetary policy leads to declines in financial markets (e.g. see Rigobon and Sack (2004). Ehrmann and Fratzcher (2009), for instance, found that contractionary monetary policy could account for as much as a 10% decline in equity values in the US.

We also observed that following policy rate shocks, sterling rose in value against most of the major currency pairs that we explored (with the exception of GBP_EUR), although these rises are of relatively little importance in the first couple of months. Subsequently, we found that sterling depreciated gradually from around the four-month mark onwards. Similar to the classic prize puzzle where contractionary shocks lead to a rise in prices, some previous findings have also documented the exchange rate puzzle, whereby a contractionary policy leads to a depreciating local currency value (e.g. see Kim and Roubini, 2000). We found some evidence of such a price puzzle in latter periods of our impulse response graphs. Nonetheless, our results with these major currencies are consistent with both economic theories as well as studies that use the more robust methodologies that account for the exchange rate puzzle such as Ivrendi and Guloglu (2010) and Barnett et al. (2016).

Figure 5.3: Impulse response of currency and financial market variables to policy rate (ISSR) shocks



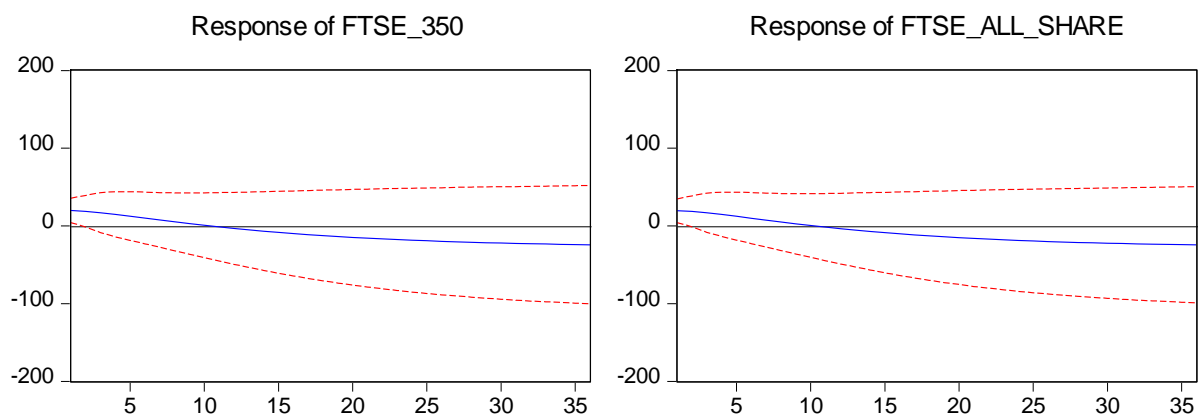
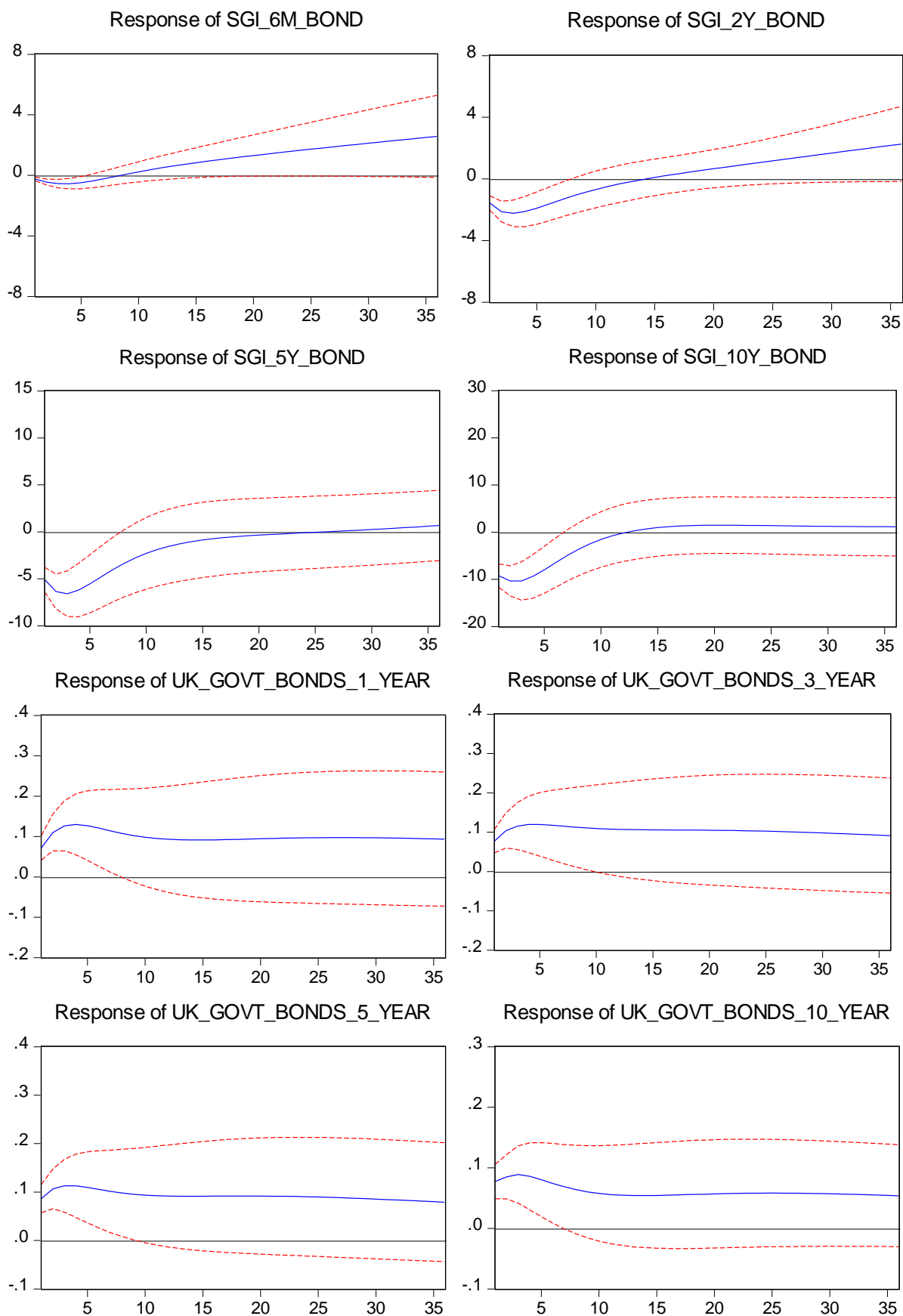


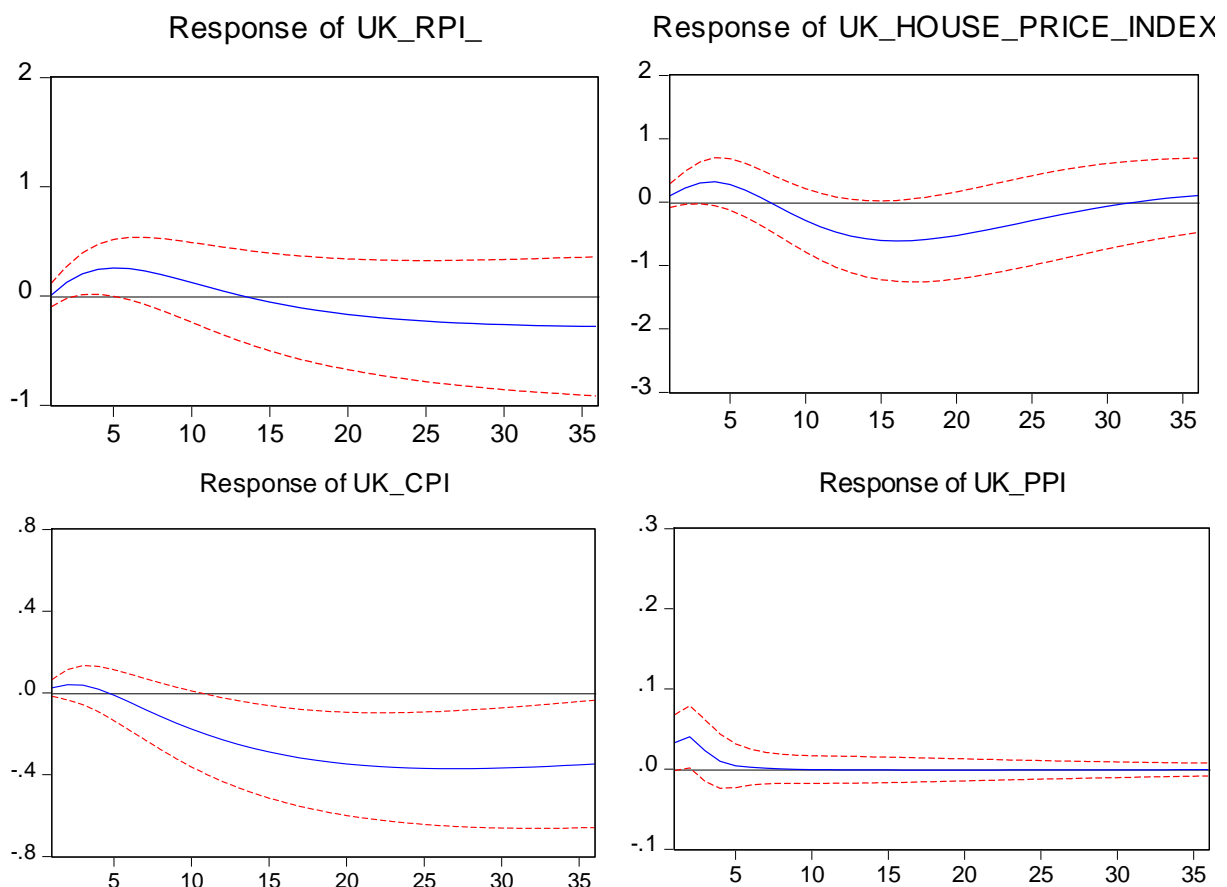
Figure 5.4 below shows the responses of our bond market variables to the policy rate. We found that the SGI bond indices, which mainly constitute corporate bonds, reacted in a different manner to the UK government bonds. Shocks to the policy rate had an initial negative impact on corporate bonds yields for up to four months, this was then reversed and bond yields tended to rise gradually from this point onwards. We found that the bonds with a longer tenor tended to exhibit a more negative response compared to the shorter bonds which have six months to maturity. In contrast, we found that the impacts on government bond notes tended to be slightly positive initially followed by a very slight fall in yields that are less persistent than corporate bonds. The initial rises in yield demonstrated following policy rate shocks are consistent with macroeconomic theory.

Figure 5.4: Impulse response of bond market variables to policy rate (ISSR) shocks



Impulse responses of inflation variables, as shown in figure 5.5 below, show that prices tended to rise briefly before then falling following shocks to the policy variable. The initial rise in prices documented here is perhaps consistent with the classic ‘price puzzle’ as identified by Sims (1992), where a contractionary policy leads to an increase in inflation as opposed to a decrease. However, inflation reverts to expected behaviour (a fall) with a lag of about two to three months. Some subsequent work in the literature, such as Henzel et al.’s work (2009), still document the price puzzle, albeit with mostly American macroeconomic data, and have tried to explain the possible channels for this anomaly with little luck. Our results are nonetheless consistent with more recent studies that use the FAVAR methodology to significantly reduce or eliminate the prize puzzle (e.g. see Korobilis 2012) as well as studies such as Ivrendi and Guloglu (2010) which uses a structural vector error correction model.

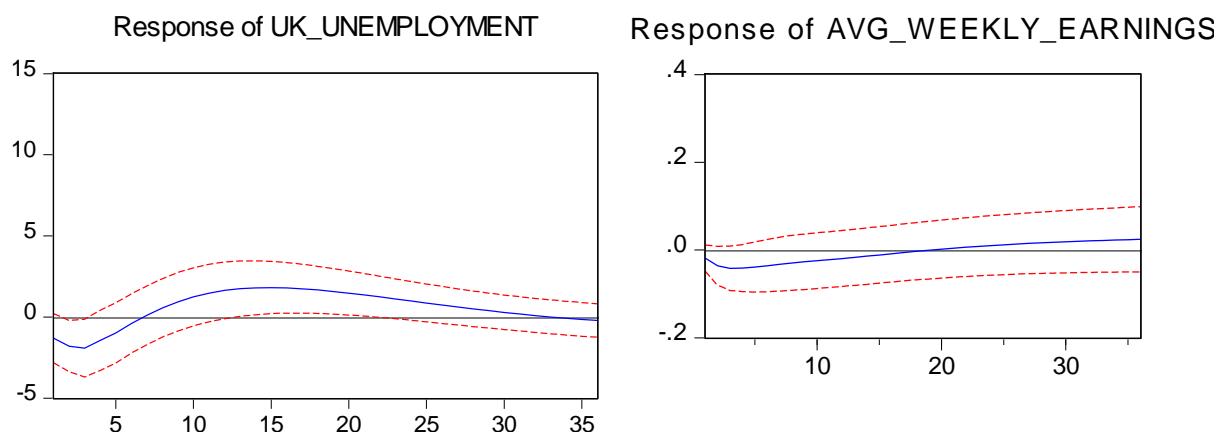
Figure 5.5: Impulse response of inflation and output variables to policy rate (ISSR) shocks

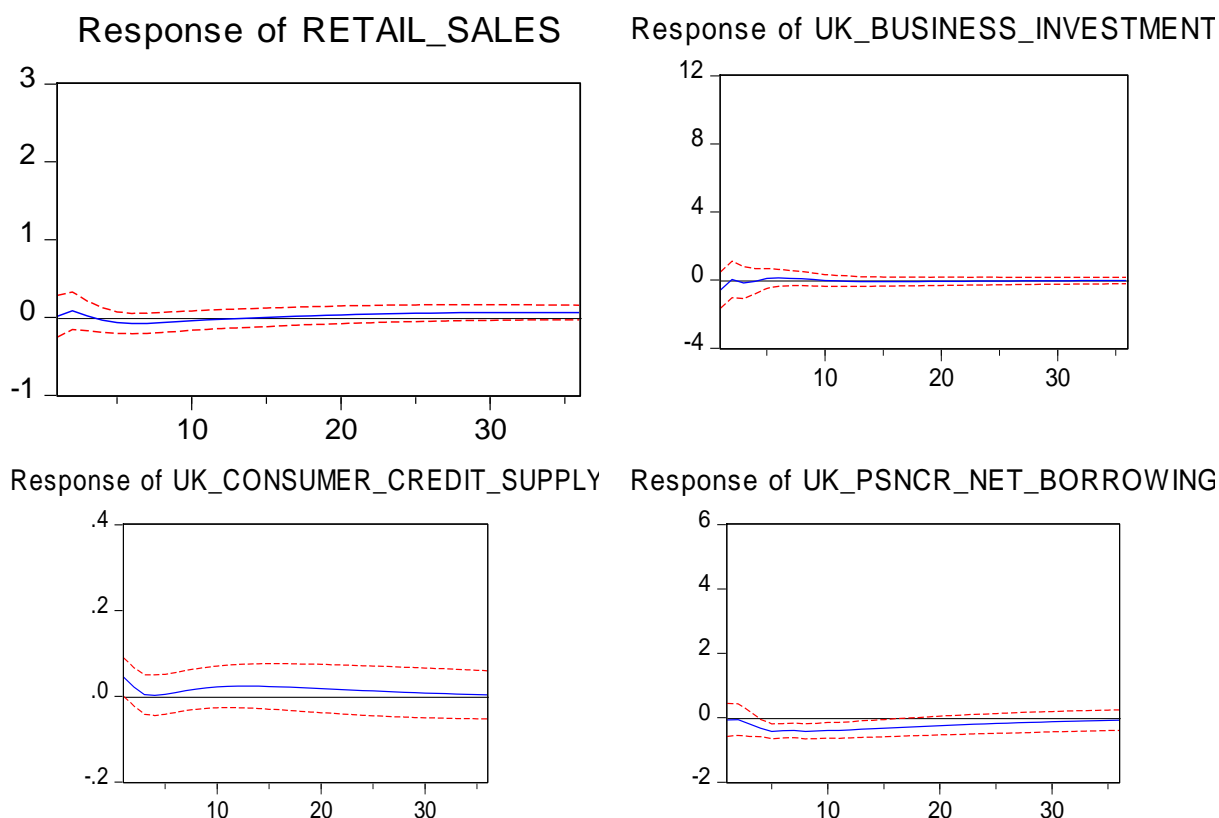




Our results for construction, industrial, services and manufacturing output in figure 5.5 above show that shocks to output variables faded out quite quickly, with the effects wearing out in as little as four months. We therefore found little evidence of the policy rate used in this study having a significant effect on output variables over the longer term.

Figure 5.6: Impulse response of other macroeconomic variables to policy rate (ISSR) shocks





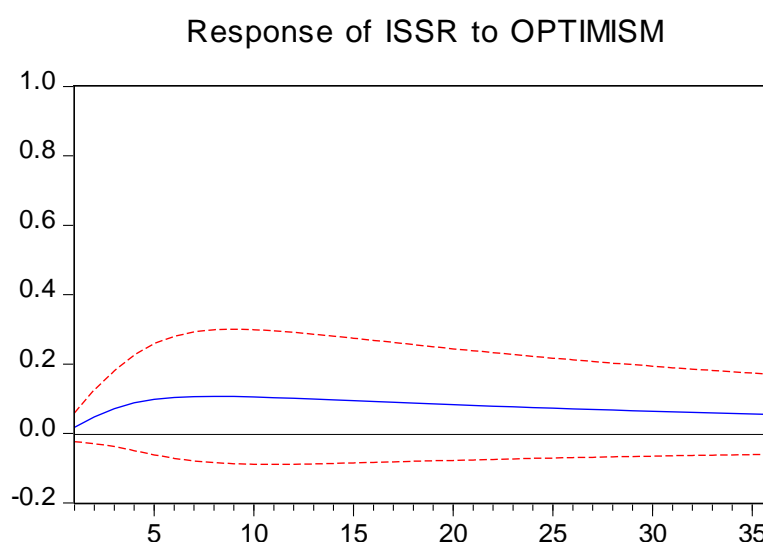
Finally, for policy rate shocks, we examined selected macroeconomic variables shown in figure 5.6 above. We found that shocks to the policy rate drove up unemployment in the long run with the effects taking about three months to kick in. The initial reaction to policy rate shocks, which firstly saw unemployment reduce, is inconsistent with economic theory. A potential explanation for this may be the delay in the time it takes for the employment market to react to policy, especially as there are labour laws in place to protect employees. The timing of the positive consistent rise in unemployment is also interesting, as it perfectly matches the results of Bernanke and Blinder (1992), who found that the unemployment rate responded to shocks in the federal funds rate in the desired manner only about nine months after the shock. Similar to our analysis which shows unemployment rising from about eight months until about twenty-eight months, they also found that shocks to the policy rate raised unemployment from about nine months until it stagnated at around twenty-four months. Effects on business investment and retail sales were almost non-existent and wore out very quickly. As expected, policy rate shocks led to an immediate reduction in consumer credit supplied as well as public sector net cash requirement borrowed but again, most of these shocks were not very persistent beyond the fourth period.

5.4.2 The effects of a change in optimism

The role of optimism in central bank communication is very important in a zero lower bound environment as this sentiment can play a vital role in driving short-term expectations in the desired direction of the bank, similar to policy rate changes. Particularly, the financial press over the past few years has often been very critical of the level of central bank optimism communicated via policy documents as it supposedly helps them parse the potential for a central bank's rate rise. Reports often tend to discuss optimistic news from economic fundamentals such as financial market gains and GDP growth as a signal that the bank will be looking to act on interest rates. Generally, an increase in optimism is often seen as a sign of movement in the direction of an interest rate rise and along the lines of a contractionary monetary policy. In this analysis, we therefore explore the impact of optimism shocks on a number of macroeconomic and financial variables, similar to our analysis for the policy rate.

To begin with, we explored the effects of shocks to optimism on our other policy variables, namely the policy rate and the complexity of communication. Figures 5.7 to 5.12 below show our results for these interactions.

Figure 5.7: Impulse response of policy variables to optimism shocks



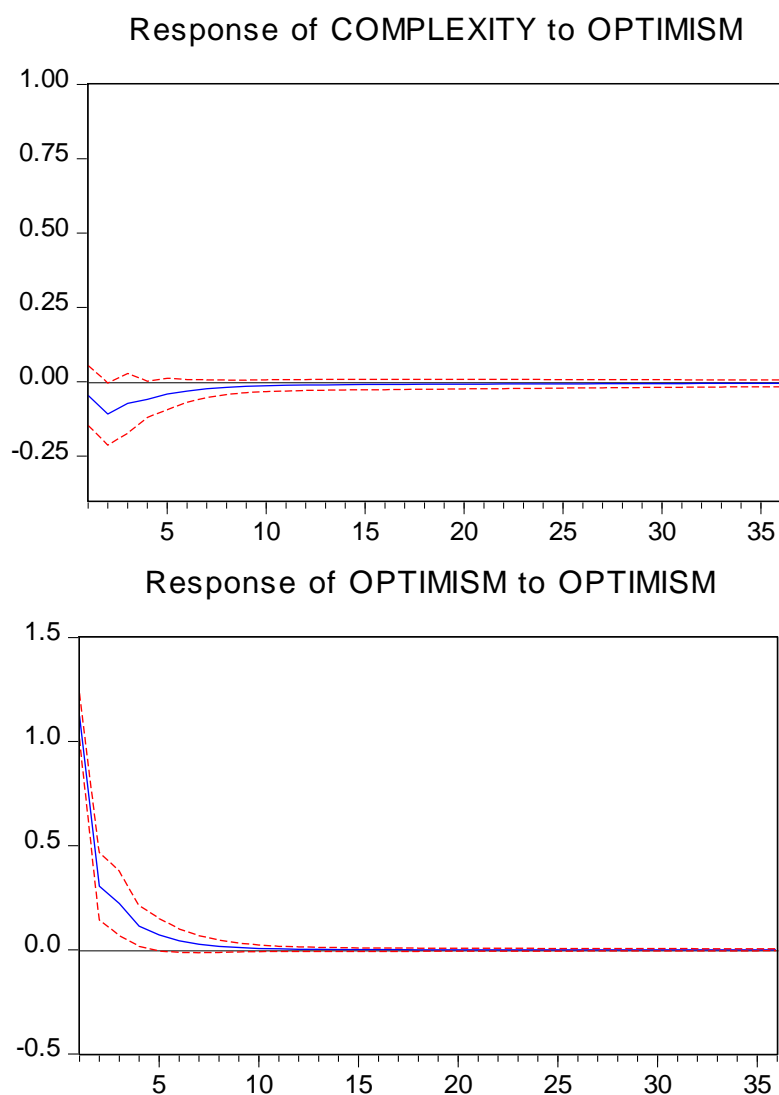
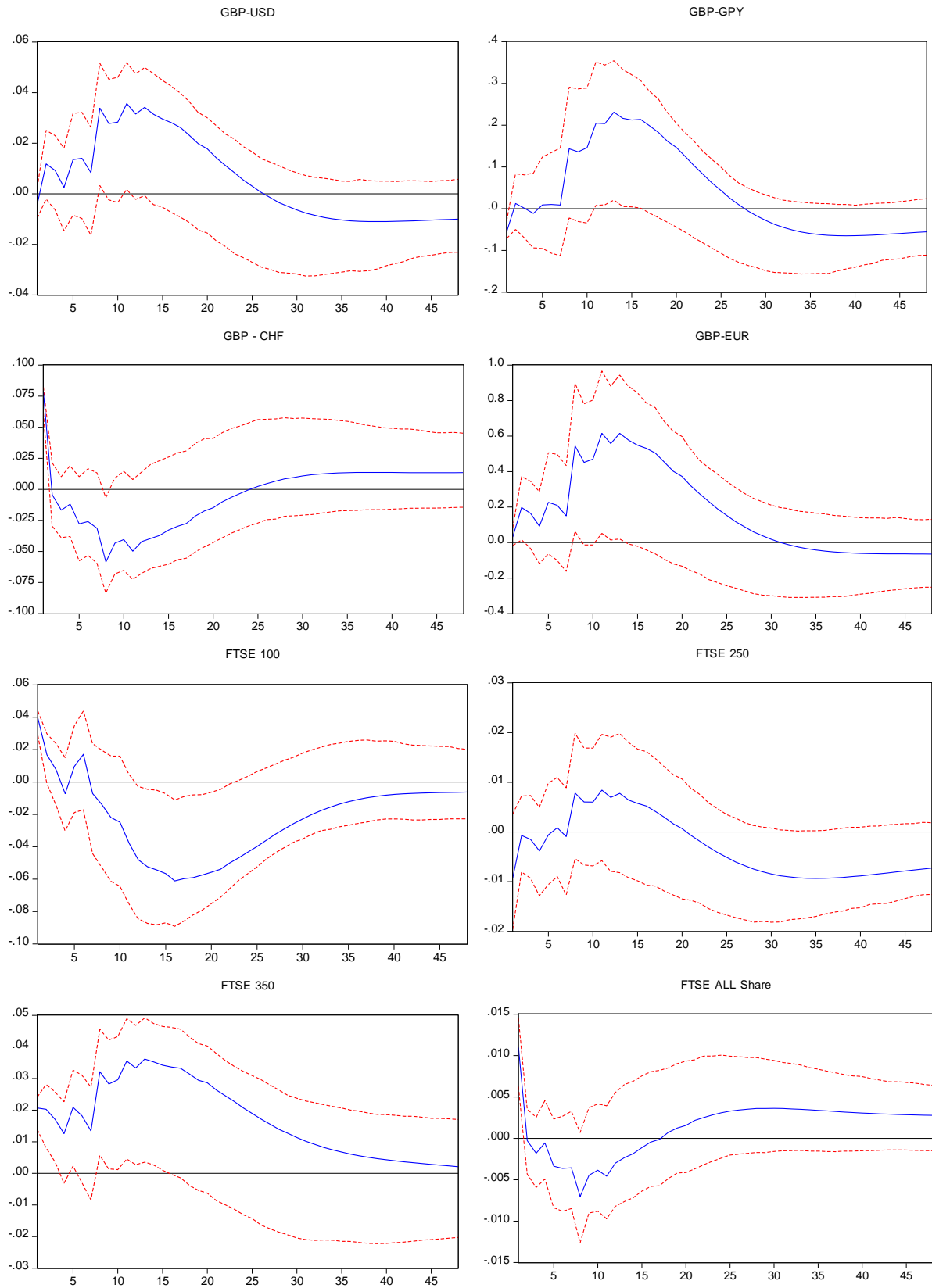


Figure 5.7 above shows some confirmation that optimism shocks led to a rise in the policy rate, although this increase may be considered to be somewhat measured and largely insignificant in parts. Complexity also tended to increase over the longer term but the immediate response of communication was to be less complex in the period immediately following an optimism shock. A positive shock to optimism is therefore by our interpretation, similar to a contractionary monetary policy move.

Figure 5.8: Impulse response of currency and financial markets variables to optimism shocks



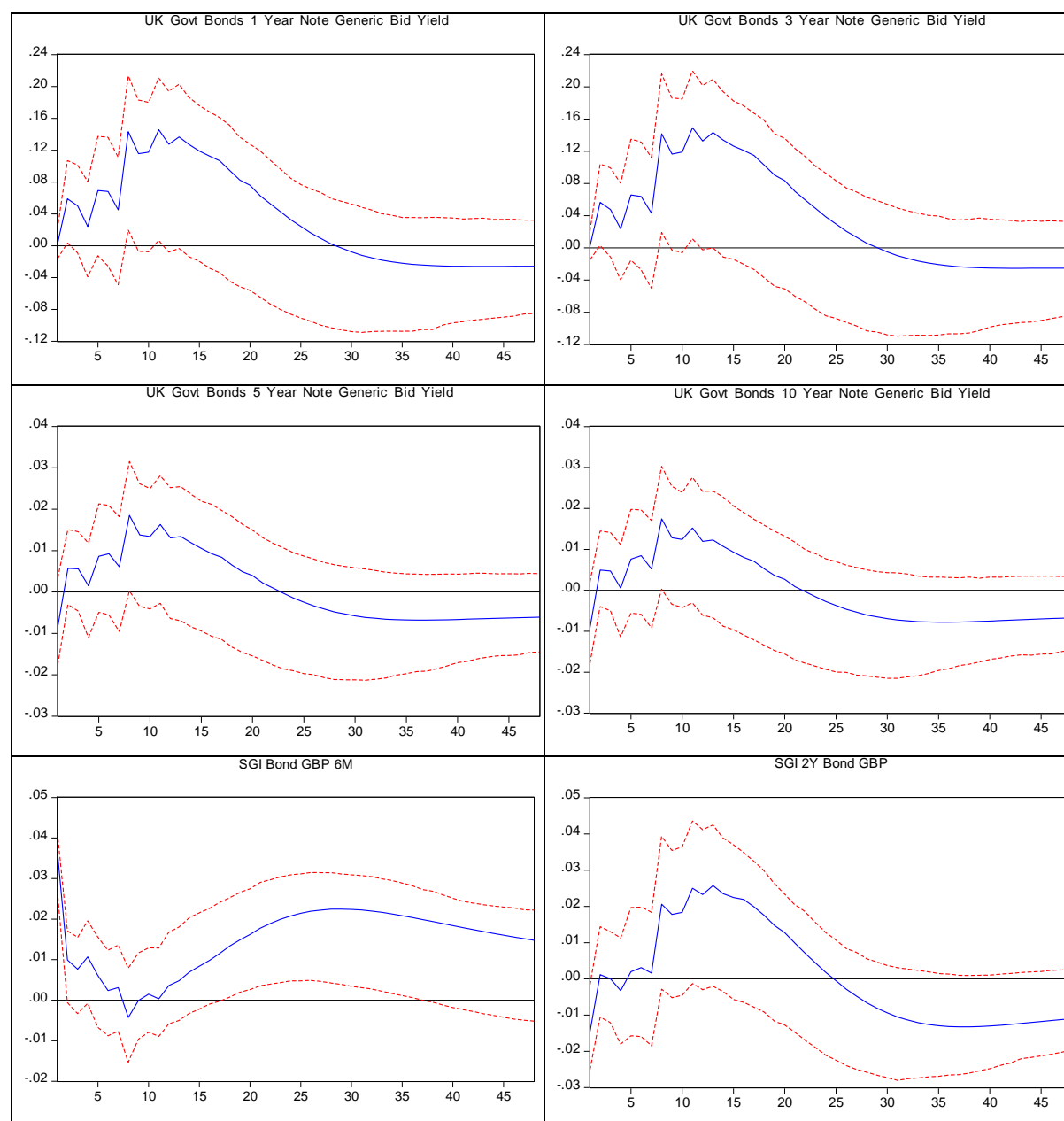
In the next set of analysis, we explore the effects of optimism shocks on the currency markets and stock markets (Fig. 5.8). Particularly, we explored how optimism shocks drive the value of the pound (GBP) relative to the US dollar (USD), the Japanese yen (JPY), Swiss franc (CHF) and the euro (EUR). For the major currencies, including the EUR, the USD and the JPY, our results consistently showed an initial increase in the value of the pound following shocks to optimism, although these took a couple of months to be significant in some cases. If we assume optimism shocks to impact the currency markets as a policy rate would, our results suggest some evidence of a ‘price puzzle’ with our GBP/CHF values which document negative reactions to shocks in optimism. Similar to the prize puzzle in policy rate analysis on inflation, some previous findings have documented the exchange rate puzzle, whereby a contractionary policy leads to a depreciating local currency value (e.g. see Kim and Roubini, 2000). Nonetheless, our results with the major currencies are consistent with both economic theories as well as studies that use the more robust methodologies that account for the exchange rate puzzle such as Ivrendi and Guloglu (2010) and Barnett et al. (2016).

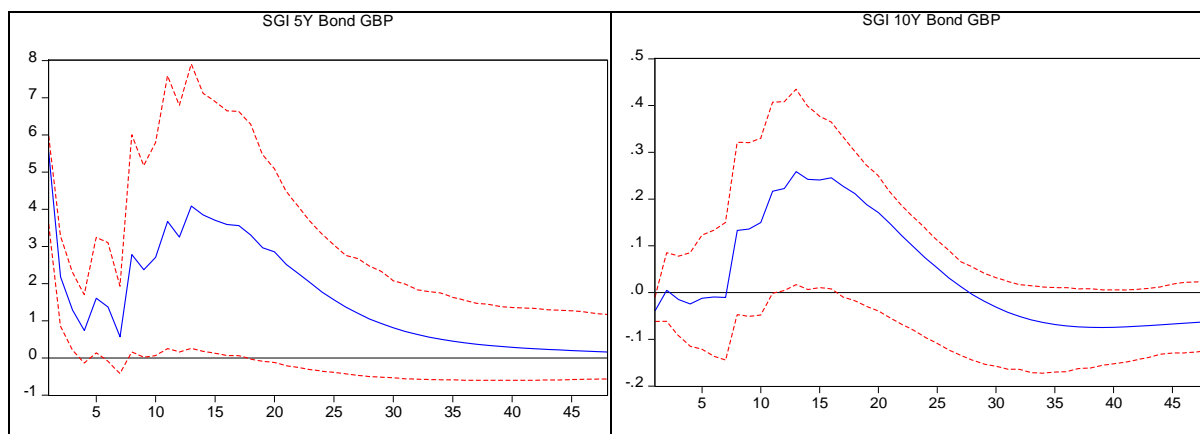
For the financial markets, we explored the effect of optimism shocks on the FTSE 100, the FTSE 250, the FTSE 350 and the FTSE All Share indices. Our results show that most of the financial indices with the exception of the FTSE 250, which is insignificant, initially reacted negatively to shocks in optimism, with most of these shocks lasting several months following the communication. Similar to our price level analysis, the behaviour of the financial markets seems to reflect a contractionary monetary policy. The intuition here is that with increased optimism in policy communication, firms’ expectations are for a rise in interest rates and they respond by reducing or postponing investment due to the increased cost of raising capital. Similarly, on the consumer side, in a contractionary environment, investors will prefer savings in anticipation of higher interest rates rather than investing. These two combined effects will have the effect of putting downward pressure on the financial markets and are in line with the expectations of economic theory (e.g. see Rigobon and Sack 2004).

The insignificance of the FTSE 250, which is an index of the next largest 250 publicly listed companies (and much less significant effects of the FTSE 350, which combines the FTSE100 and the FTSE 250), suggests that the size of the companies matters when it comes to reacting to central bank optimism. The larger FTSE 100 firms exhibit a negative and significant response to central bank communication while the indices with smaller firms do not significantly react. This makes sense as it is likely to be investors in these larger firms, such as institutional investments and larger funds, that tend to be more sensitive to central bank communication. Furthermore, these findings are consistent with studies in the literature that

suggest that smaller firms are less impacted by monetary policy shocks (e.g. see Thorbecke 1997). The hypothesis behind this evidence is that monetary policy only matters in part because it affects a firm's access to credit. Indeed, where smaller firms are included, as in the case of the FTSE All Share, the negative effects of the shocks wear out more quickly, lasting about eight months before the negative trend is reversed, whereas the negative effects of optimism shocks to the FTSE 100 last twice as long – about 16 months – before returns start to pick up again.

Figure 5.9: Impulse response of bond yields to optimism shocks





Next, in figure 5.9 above, we consider the reaction of bond yield to shocks in optimism using four government bond yield maturities as well as four Société Générale Bond indices (SGI) that contain a range of bonds (corporate and government) with similar maturities. For all the government bond indices which include maturities from one year to ten years, we observed that shocks to optimism led to increased yield, which is consistent with monetary policy theory expectations for contractionary policy shocks. Similar to studies such as Rigobon and Sack (2004) who found that the shorter-term maturities reacted more to shocks than longer-term maturities did, we found evidence that the reactions to the one-year and three-year maturities were more significant than those of the five-year and ten-year maturities. With the SGI bond index, however, we uncovered mixed results which may suggest that certain elements within the index react in different ways. We observed that only the ten-year maturity reacts as expected by showing a positive response. The short-term six-month maturity as well as the five-year maturity both show an immediate decline in yield. Generally, it is difficult to infer a pattern of direction with bond indices due to the unique nature of each of the constituent bonds, which may vary widely in terms of credit ratings and individual issuer reputation. Our key finding here has to do with the behaviour of government bonds which is largely consistent with the theoretical expectations of a rate rise.

Figure 5.10: Impulse response of inflation variables to optimism shocks

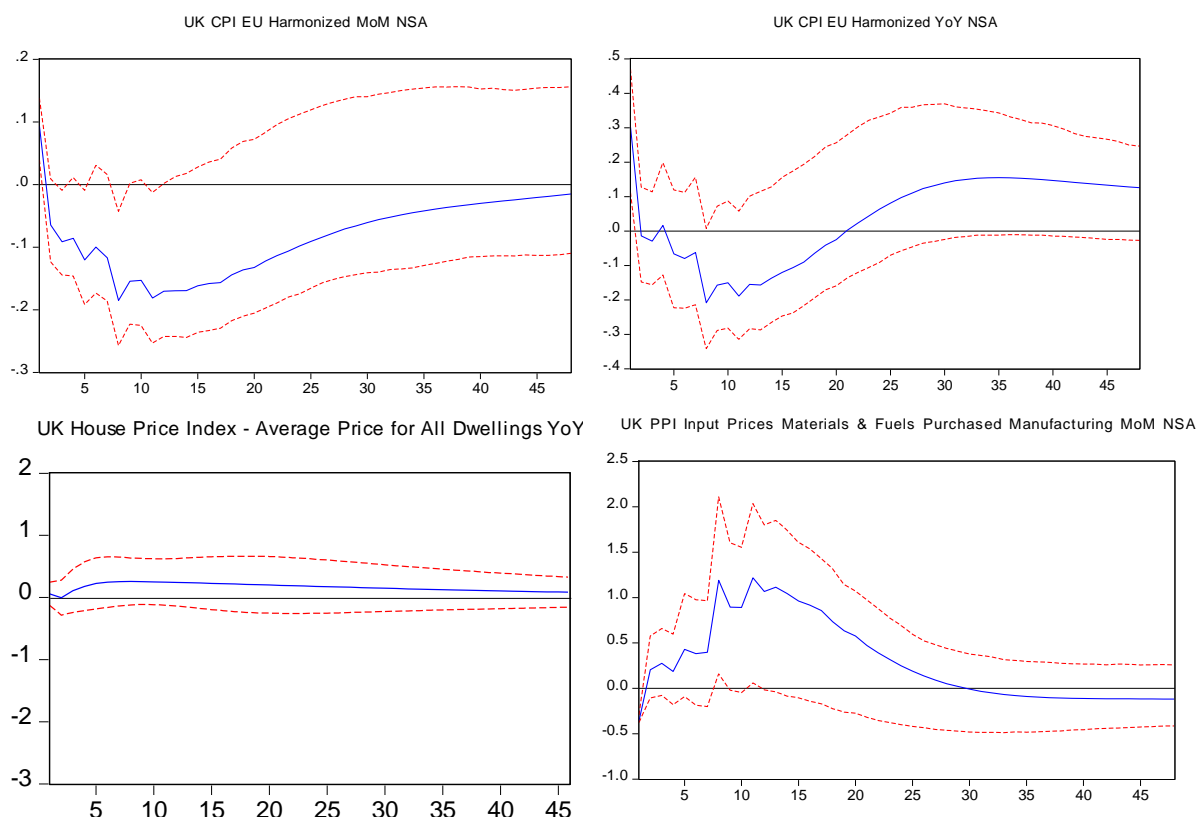
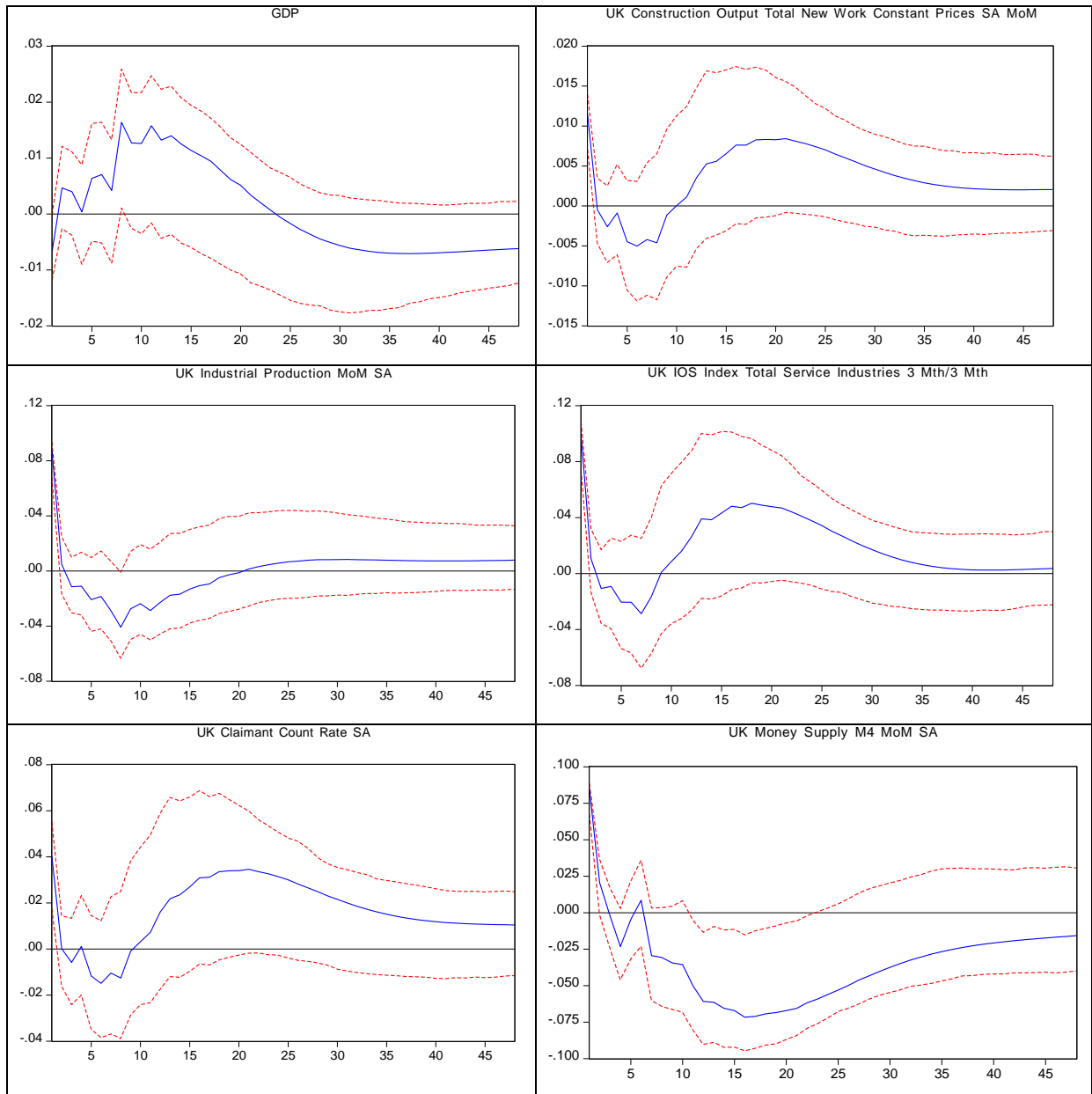


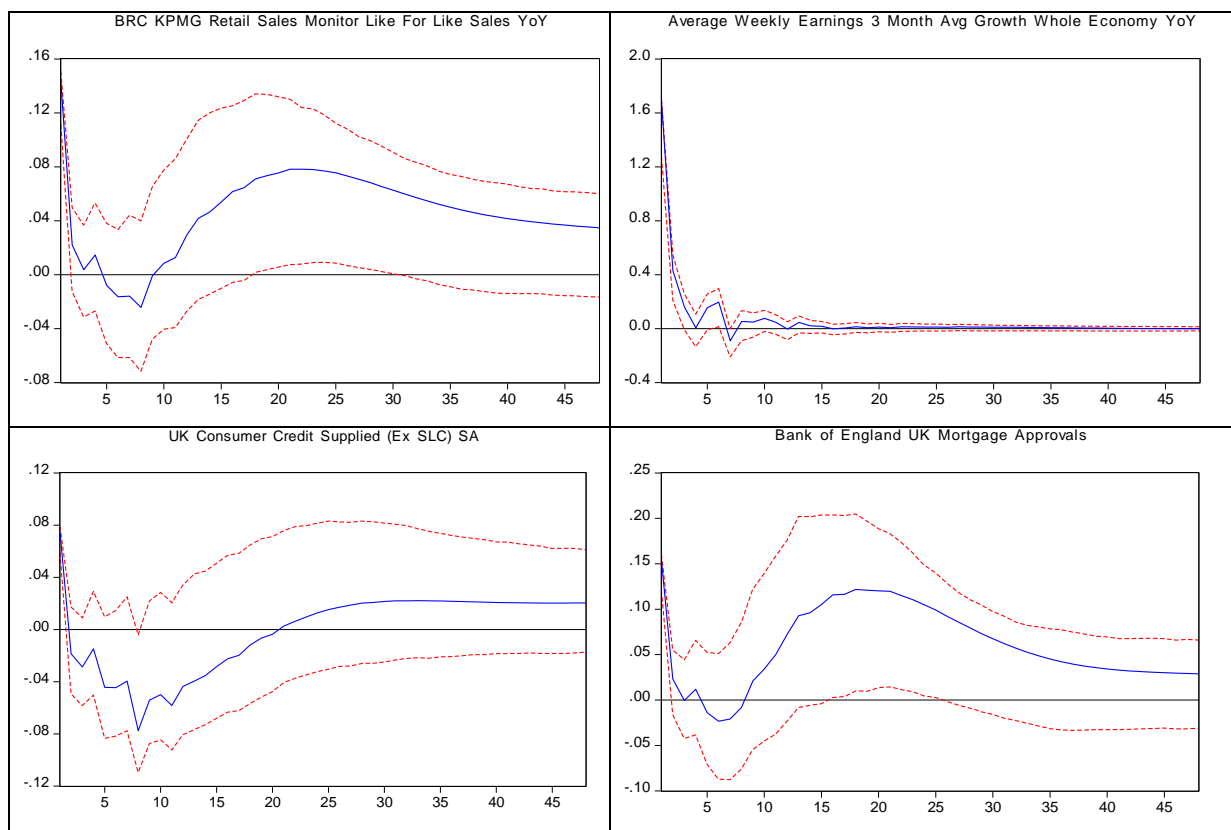
Figure 5.10 above shows the responses to the various measures of inflation explored to optimism shocks. We noticed that overall, shocks to optimism in the BoE's communication seemed to lead to an immediate fall in inflation as measured by the CPI after the communication was made. The declining effects of these shocks on inflation seemed to persist for up to ten months, after which inflation started to rise again. The effects of these shocks are different when we consider inflation from the demand side (consumers) as opposed to the supply side (producers). We found that optimism shocks led to an increase rather than a decrease in the PPI variable, implying that input prices respond to optimism shocks in a different manner. It could therefore be suggested that optimism tone in central bank communication drives down prices via the consumption channel but drives up prices via the investment channel. The observation that house prices also fall sharply following shocks to optimism further supports our argument that prices are mostly affected via the consumption channel (assuming house purchases are driven by consumption rather than investment motives).

The rationale for this may lie in the fact that optimism drives expectations of a rate rise and, as such, consumers hold back on spending and therefore demand falls with the subsequent result of a fall in inflation. Producers, on the other hand, seem to be increasing investment

inputs in anticipation of a rate rise due to increased optimism, which then drives up the prices of inputs.

Figure 5.11: Impulse response of output and real economic activity variables to optimism shocks.





Finally, we explored the effect of shocks to optimism in the bank's communication on certain output and economic variables which cover GDP, construction output, industrial production, and the index of services variable which measures value added for the services industry. The latter three components highlighted above contribute significantly to the overall GDP value and are therefore important in understanding the role that policy shocks play in influencing output. Consistent with our previous analysis, the responses of these variables were similar to those under a contractionary policy. We found evidence that shocks to optimism had a cooling effect on economic activity by driving negative responses in these variables. With GDP, the effects of the shock were insignificant after eight months, after which a negative response was observed. More definitive were the responses of construction output, industrial production, and the index of services, which all showed a sharp decline following shocks to optimism. These patterns of responses are very similar to those expressed in the monetary policy literature as to how output reacts to contractionary shocks. Particularly, the literature on the 'credit channel' of monetary policy transmission suggests that real output such as construction, industrial and services production reduces following perception of a contractionary policy, because the external finance premium which is the cost of raising outside capital by firms rises (see Bernanke and Getler 1995). Overall, all the impulse responses

generally support the theoretical argument that contractionary shocks to monetary policy have the effect of reducing aggregate output levels.

Furthermore, we explored the effect of optimism shocks on aggregate credit availability and sales variables. We found further evidence that optimism shocks lead to reduced credit availability and a fall in sales synonymous with a rate rise. The consumer credit supplied, the mortgage approval rate and the money supplied all suddenly declined following shocks to optimism. We also documented evidence of a sharp decline in retail sales following shocks to optimism. The fall in retail sales was significantly sharper than the response of aggregate output variables above, and this may be due to the argument that durable goods seem to react faster and stronger to contractionary monetary policy than non-durable goods, as evidenced by Erceg and Levin (2006). The main reason for this is the direct impact of an interest rate rise on the cost and availability of credit, which was observed to be significant in our study and which subsequently impacts consumers' purchasing ability significantly. Along these lines, we also noticed a sharp fall in weekly earnings within the economy, which again tallies with our analysis of the effects of a contractionary policy.

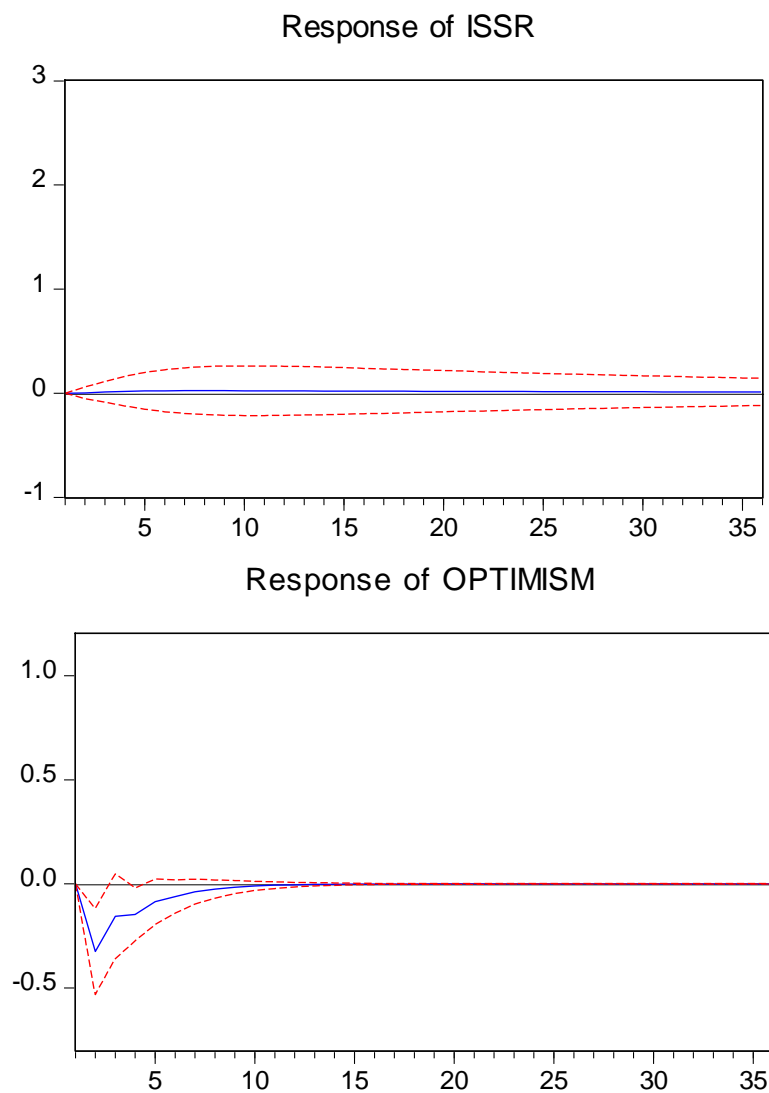
Interestingly, we did, however, observe a potential anomaly with the unemployment variable as measured by the claimant count. Here, optimism shocks tended to reduce unemployment initially in a manner that is inconsistent with economic theory, although this was subsequently reversed. We observed that although unemployment fell immediately after an optimism shock, it rose after three months as expected and fell again for a further two months before continuing to rise, as one would expect, for another eighteen to twenty months.

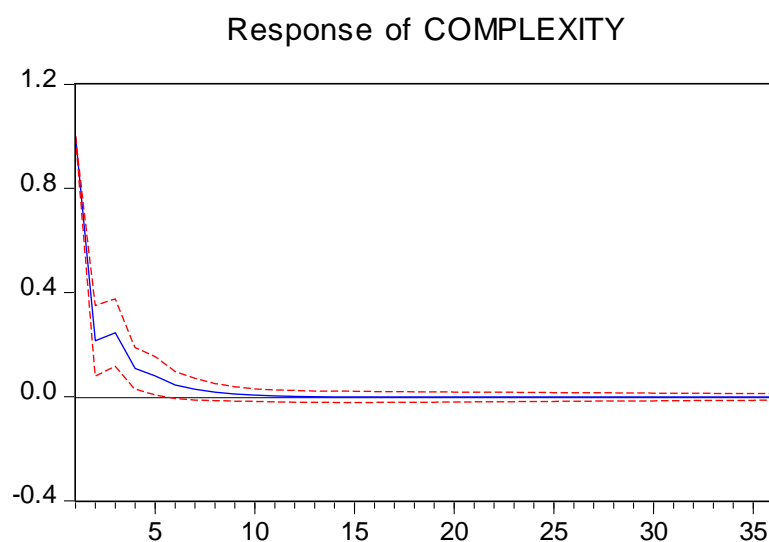
5.4.3 The effects of a change in complexity

As highlighted in previous sections of our work, the role of clarity (and complexity) of communication in macroeconomic policy making has become very important due to the increased need for transparency and accountability especially among inflation-targeting central banks. As Bulir et al. (2013) highlight, central banks have an incentive to vary the clarity of their communications to suit their policy objective. It is this potential behaviour and ability of central banks to tailor communication to achieve their aims that makes the evaluation of the clarity of central bank communication necessary. Given that there is some evidence that the clarity of central bank communications affects markets (e.g. see Jansen 2011b), there is therefore an incentive to explore how shocks to clarity influence macroeconomic and other financial variables.

To this end, we extended our analysis using the FAVAR methodology to explore the effects of shocks from the complexity of communication to our macroeconomic and financial variables of interest. Our intuition here is that if central banks do indeed vary the complexity of their communication to meet their policy objectives, then complexity can be explored within a macroeconomic policy framework alongside other policy variables. In our analysis below, we explored how innovations from communication complexity were transmitted across our macroeconomic and financial variables of interest. Similar to our previous analyses, we first explored the effects of shocks to complexity on our other policy variables, namely the policy rate and optimism. Figures 5.12 to 5.16 below show our results for this interaction.

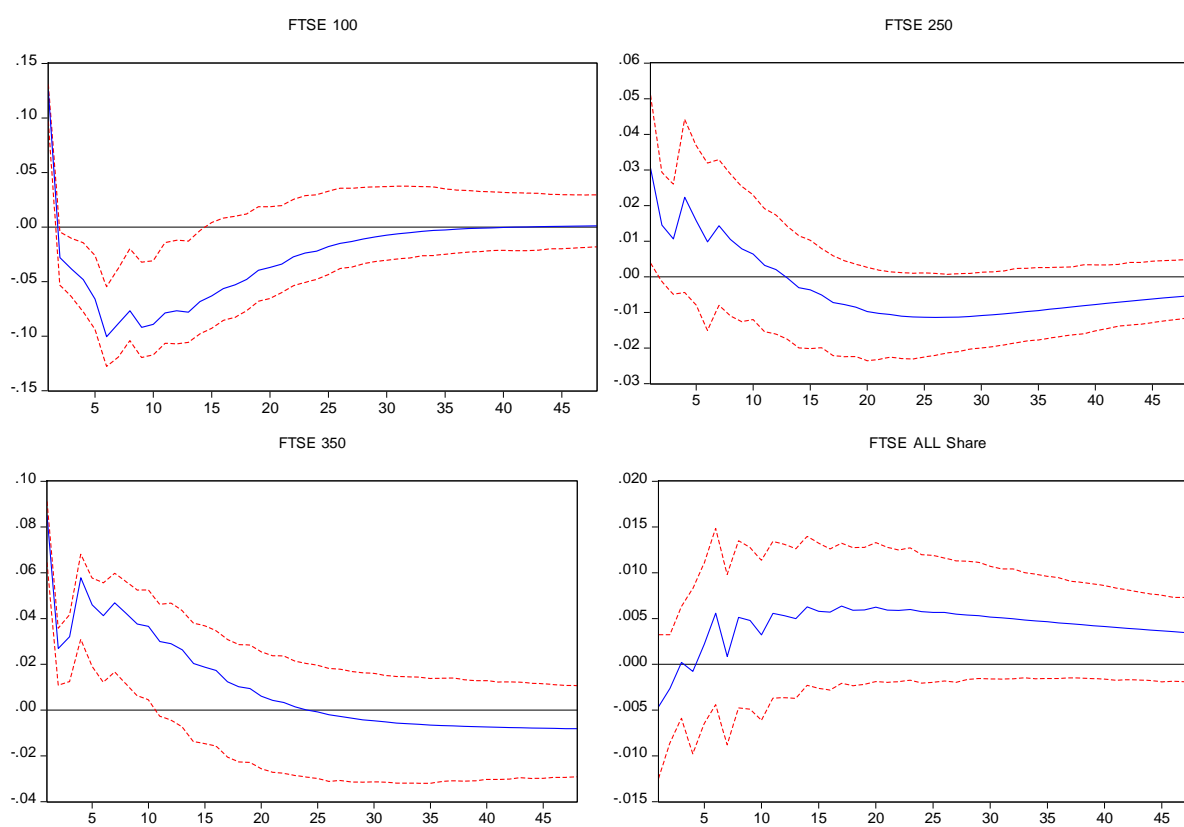
Figure 5.12: Impulse response of policy variables to complexity shocks





On the effects of complexity on other policy variables we explored, we found that shocks to complexity impacted the level of optimism in communication the most (Fig. 5.12). More complex communication seems to significantly drive down the levels of optimism in policy communication.

Figure 5.13: Impulse response of currency and financial markets variables to complexity shocks



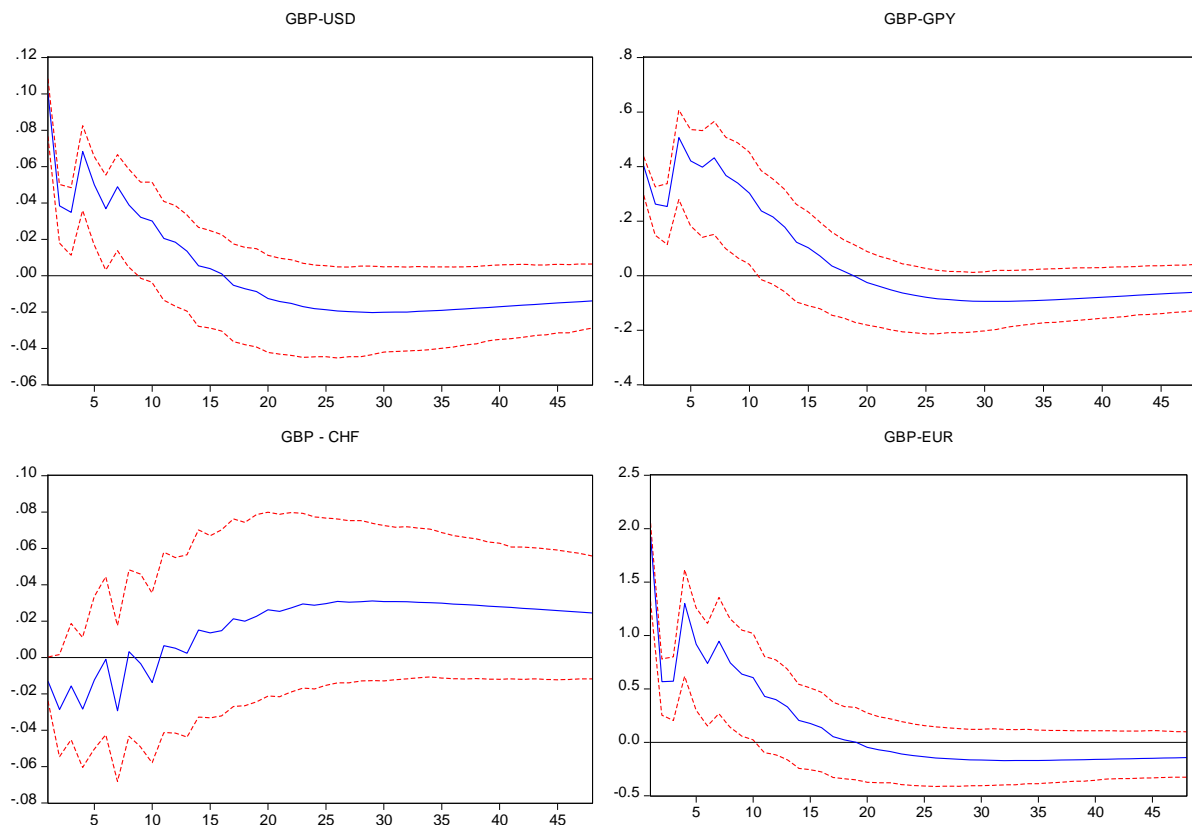


Figure 5.13 above compares impulse response functions from shocks to complexity of communication on major currencies relative to the pound as well as the major stock market indices. Generally, we found evidence that shocks to complexity tended to lead to a depressed pound value. Although the pound demonstrated an immediate and sharp decline in value relative to most of the major currencies, in some cases, these effects were not significant until a couple of months later. The GBP-USD, GBP-EUR and GBP-GPY, for instance, showed significant lags in the time it took for the negative effects to kick in. The idea that the pound falls in value following shocks to clarity can be explained by an analysis similar to the stock market. More complexity in communicating policy by the bank leads to lesser foreign investment in the UK and subsequently a sell off of the pound that will trigger a decline.

Next, we explored the impulse responses of financial markets returns to complexity shocks. We found here that the largest firms, as captured by the FTSE100, demonstrate the most significant responses to the complexity of the BoE's communication. Following shocks to complexity, we found evidence that the FTSE100 returns fell sharply but only for about five months, after which the market returns started to rise. The reasoning here is that where the bank becomes more unclear about its policy decision, the financial markets react with falling stock market prices and subsequently returns. Indeed, if the bank is perceived to have more

information and the financial market participants look to the bank for clarity, if they then do not get satisfactory clarity from the bank, this will trigger a selloff of assets that will then lead to a stock market decline. What is also interesting is that when we consider the smaller companies as captured by the FTSE250, we find lesser evidence of a response to communication as the larger FTSE100 companies do. In fact, when we consider the inclusion of much wider range of smaller companies as captured by the FTSE All Share, complexity of communication as a whole loses its significance.

Figure 5.14: Impulse response of bond yields to complexity shocks

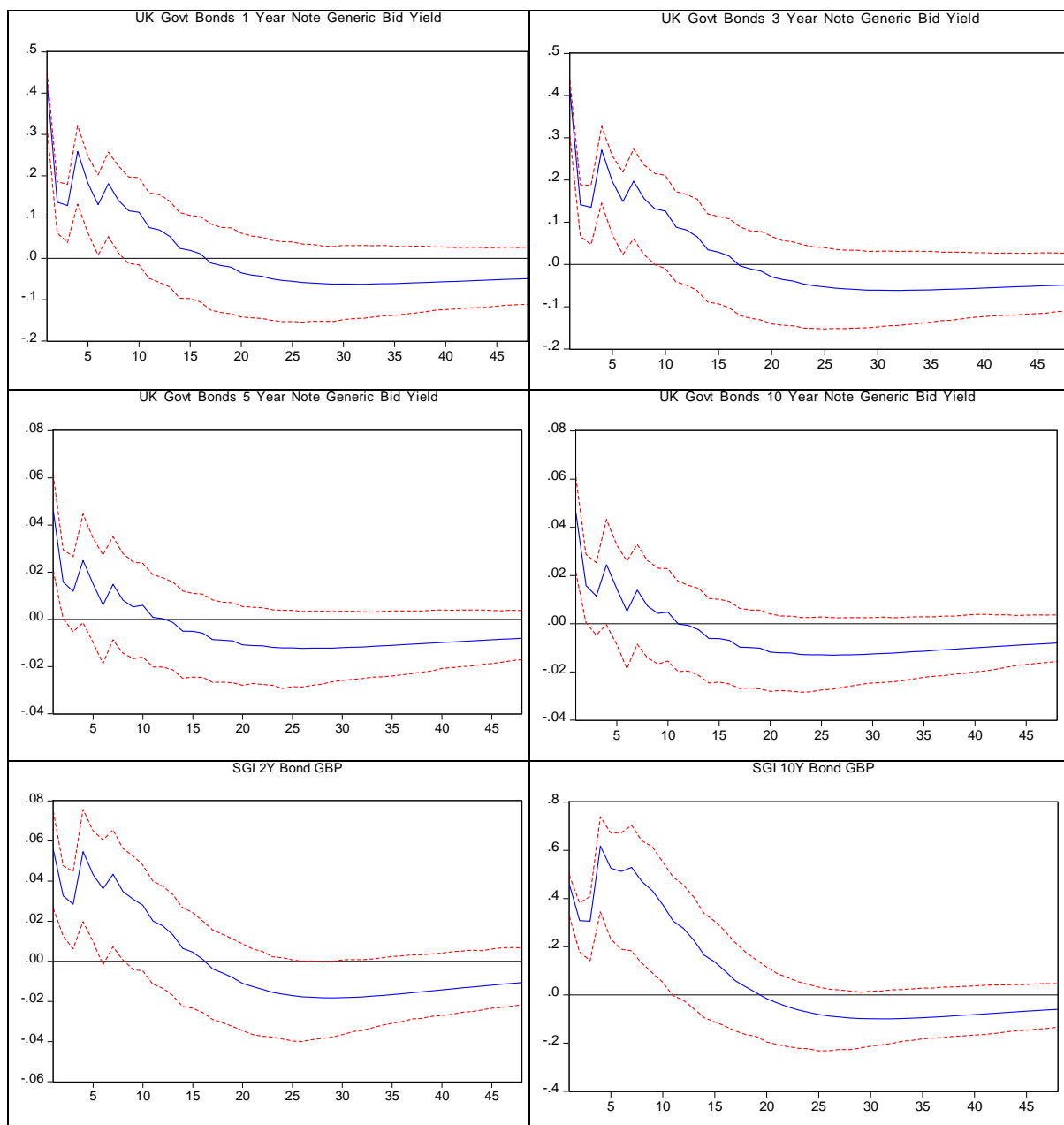


Table 5.14 above shows the impulse responses of bond yields to shocks in complexity of communication. We observed that across all the bonds considered, yields fell following

shocks to complexity. In particular, we noticed that the effects of the shocks on falling yields were more significant with the longer term five- and ten-year government bond yields. For the one- and three-year government bond yields, we found evidence of a delayed significance of the falling yield in response to clarity shocks. The two-year and ten-year SGI bond indexes also showed a decline in bond yields over the longer term with a delayed response in significance. We argue that the main channel through which yield falls after a clarity shock is through falling inflation as we have demonstrated above. Bond investors tend to hold on to bond coupon payments when they anticipate inflation will fall as this will push down yield values (via increasing demand and bond prices). Since complexity shocks lead to an instant fall in inflation, the effect of the falling inflation means that bond yield will remain lower following shocks to complexity. In simple terms, when the bank communicates its policy decision in a complex manner, the resulting lower inflation from such a scenario may also lead to bond yield falling as demonstrated above.

Figure 5.15: Impulse response of inflation variables to complexity shocks

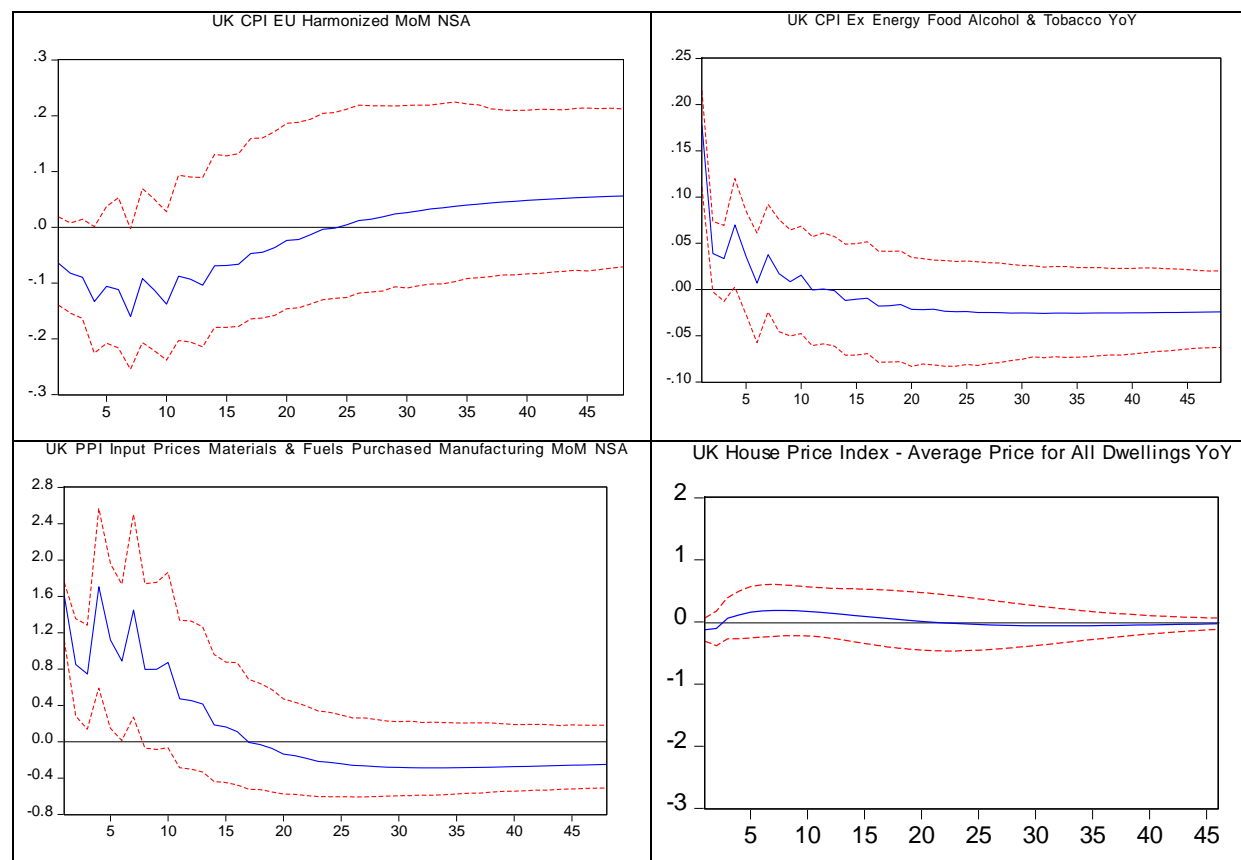
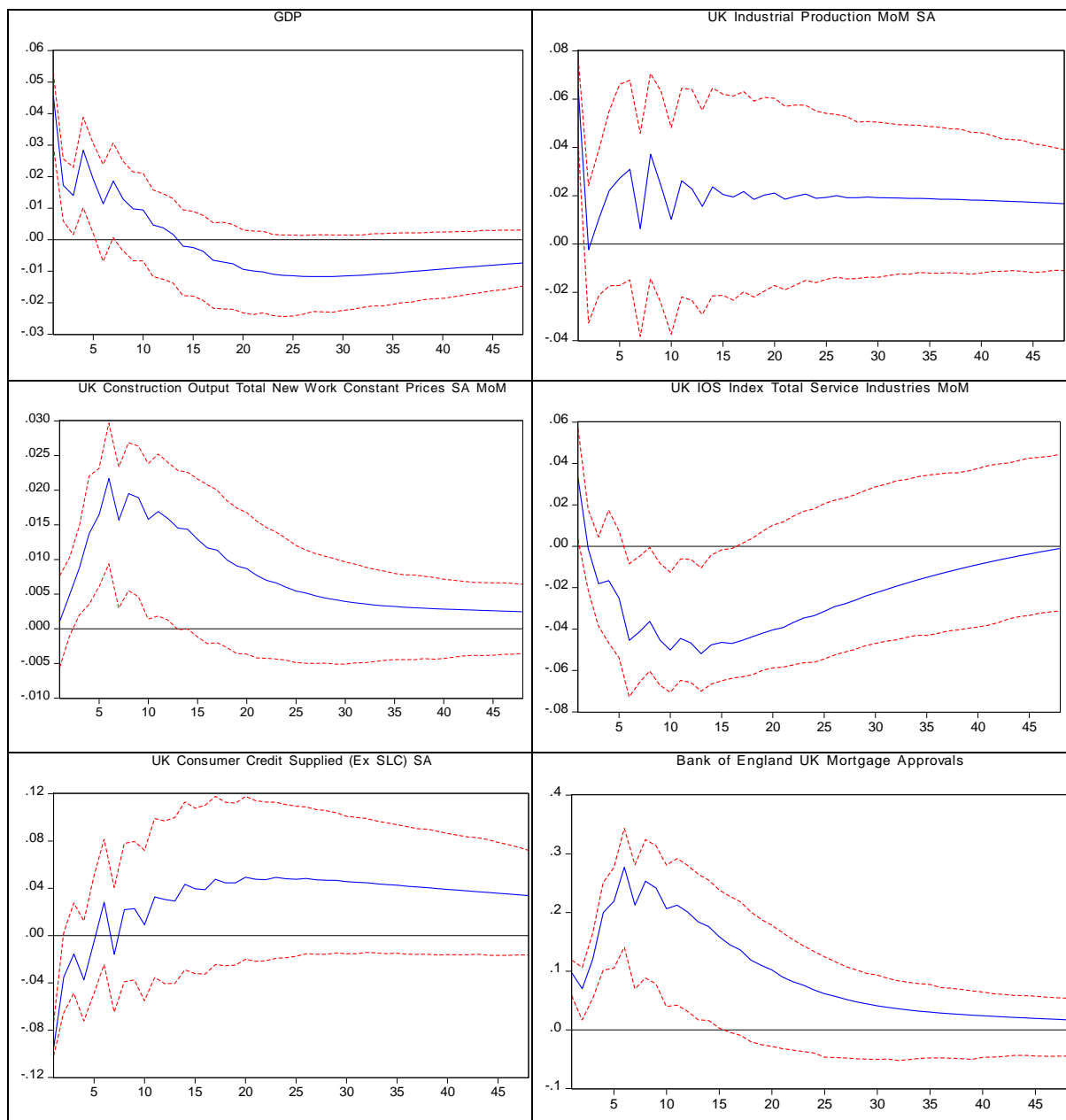
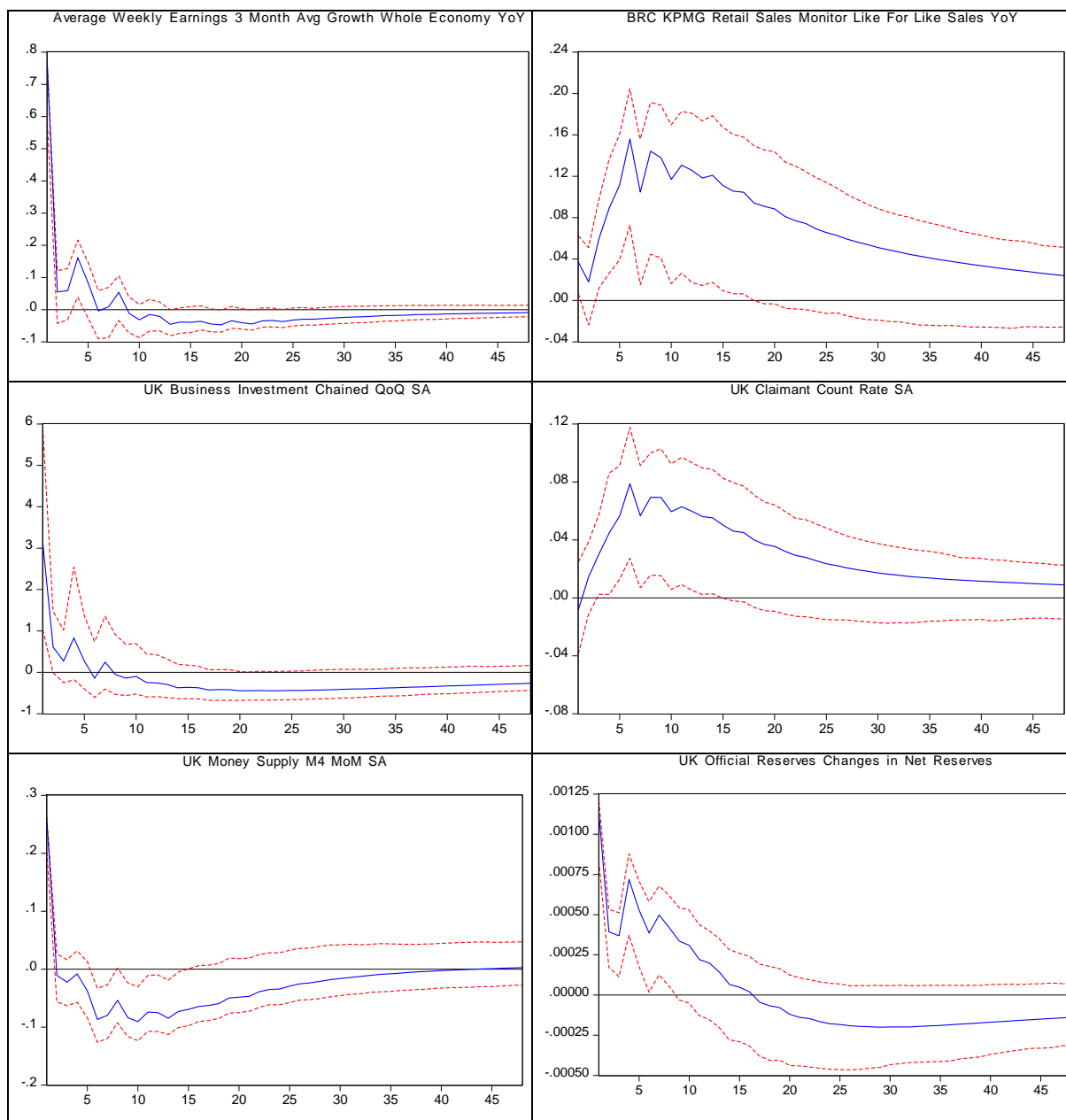


Figure 5.15 above shows the impulse response functions of complexity shocks to the inflation level. Generally, we observed that shocks to complexity tended to reduce inflationary pressures as measured by the above inflation variables. Particularly, the CPI measure fell sharply over the first ten months and this was then followed by a smooth decline in prices that eventually levelled off after a further eight months. The idea that complexity shocks reduce inflation is therefore conceivable given that when markets are unclear about the direction of policy from the central bank, they would hold back on spending and consumption, which will lead to reduced inflation.

Figure 5.16: Impulse response of output and real economic activity variables to optimism shocks





Finally, we explored the effects of shocks to key output variables as well as other relevant macroeconomic variables. For output, we found evidence that GDP, industrial production and services output fell immediately after shocks to complexity, although GDP only became significant with about a five-month delay. Shocks to industrial output tended to wear out relatively quicker and then stabilise after about twelve months. These indicate that with more complexity on policy direction, output falls in accordance with our previous arguments that such increased complexity reduces domestic investment as producers and consumers are relatively unclear about the policy path of the bank. Construction output, on the other hand, was found to increase following shocks to clarity, implying that construction output rises following more communication complexity. This may be due to the construction industry

requiring more time to adjust to policy decisions since, generally, construction decisions are taken considerably in advance of their implementation. We did indeed observe that after five months following the communication, construction output then seemed to respond negatively with more complexity.

For other macroeconomic measures that we explored, we noticed mixed results on the response of complexity shocks. Credit availability as measured by the amount of consumer credit supplied rose slowly, whilst mortgage approval rates also rose but only became significant when the approval rates fell after about fifteen months. As expected, however, earnings, business investment and the money supply all seem to respond to more complexity in policy communication by declining. Furthermore, in line with this, unemployment as measured by the claimant count rose but then fell after six months. These patterns tie in very well with our argument that more complex communication leads to reduced economic activity. Perhaps an anomaly here is the response of retail sales, which seemed to rise rather than fall following complexity shocks, given that unemployment rose and output, earnings, business investment and money supply all fell. We argue that this may have been mainly driven by rising credit availability, especially within the consumer markets. Indeed, given that our evidence shows that consumer credit supplied rose, there is a strong case for the growth in retail sales being driven by the rising consumer credit supplied. Another obvious supporting argument for this is also the fact that the retail sales rises were only temporary and fell sharply after just six months.

5.4.5 Analysis of forecast error variance decomposition (FEVD)

To evaluate the magnitude of the impact of innovations in our policy variables, especially the communication variables on the macroeconomic and financial variables, we carried out an analysis of the forecast error variance decomposition derived from our FAVAR analysis. There is some evidence in earlier studies, such as Campbell and Ammer (1993), that news about future stock excess return and news about future inflation are the main drivers of innovations in the stock and bond markets respectively. Their study shows that the impact of news on innovation in these markets is significantly more than the impact of policy rate on innovations. Similar to the above study, our FEVD analysis basically highlights the contributions of each of the policy variables to the variance of macroeconomic and financial variables over 24 periods (i.e. 24 months). Tables 5.1 to 5.5 below show the results of our FEVD analysis.

Tables 5.1 and 5.2 show the magnitude of the shocks of each of the policy variables on the variance of the currency and stock markets. The column labelled ‘total’ shows the combined magnitude of ISSR, optimism and complexity shocks on the overall variance of the variables, whilst the last three columns show the relative contribution of each of the policy variables to the variance of monetary shocks when combined together.

Table 5.1: Analysis of the forecast error variance decomposition (FEVD) for currency market variables

Horizon		Forecast Error Variance Decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
GBP_USD	1 month	0.45	0.28	0.11	0.84	0.54	0.33	0.13
	12 months	3.77	4.69	0.14	8.60	0.44	0.55	0.02
	24 months	3.62	5.33	0.18	9.13	0.40	0.58	0.02
GBP_JPY	1 month	0.24	0.17	0.10	0.51	0.47	0.34	0.19
	12 months	1.24	0.57	4.19	6.00	0.21	0.10	0.70
	24 months	0.86	0.46	4.90	6.21	0.14	0.07	0.79
GBP_CHF	1 month	0.54	0.06	0.24	0.84	0.64	0.07	0.28
	12 months	2.47	0.02	0.36	2.85	0.87	0.01	0.13
	24 months	1.72	0.01	0.46	2.18	0.79	0.00	0.21
GBP_EUR	1 month	0.00	0.03	0.16	0.19	0.01	0.18	0.81
	12 months	0.14	0.90	0.08	1.13	0.12	0.80	0.07
	24 months	1.22	0.94	0.10	2.25	0.54	0.42	0.04

Table 5.2: Analysis of the forecast error variance decomposition (FEVD) for stock market variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
FTSE 100	1 month	0.07	0.11	0.57	0.75	0.10	0.14	0.76
	12 months	0.34	0.70	2.13	3.17	0.11	0.22	0.67
	24 months	2.86	0.93	2.49	6.28	0.46	0.15	0.40
FTSE 250	1 month	0.11	0.04	0.61	0.76	0.14	0.05	0.80
	12 months	3.58	0.41	3.75	7.74	0.46	0.05	0.48
	24 months	22.14	0.26	4.33	26.73	0.83	0.01	0.16
FTSE 350	1 month	0.09	0.06	0.65	0.80	0.11	0.07	0.81
	12 months	0.78	0.35	2.78	3.91	0.20	0.09	0.71
	24 months	6.20	0.55	3.30	10.05	0.62	0.06	0.33
	1 month	0.09	0.05	0.64	0.77	0.12	0.06	0.82

FTSE All Share	12 months	0.81	0.28	2.82	3.91	0.21	0.07	0.72
	24 months	7.07	0.48	3.38	10.92	0.65	0.04	0.31

For the currency and stock markets, we found that the combined effects of the policy variables increased over time with the effects of policy variables at the 24-month mark, explaining up to 26% of variations in the FTSE250 index. We found these policy variables to have significantly more effect on the variations in the stock market than they did with the currency market. Our results on the relative importance of the communication variables were mixed but we found evidence that innovations in the ISSR increasingly explained the variations in the stock market over time. Interestingly, we also found that shocks to complexity of communication accounted for a significant amount of variation in the stock markets in the immediate period after the communication, with 70% to 80% of all policy shocks being accounted for by complexity of communication. We observed that as the effects of complexity wore out, the ISSR began to drive variations in the stock market more, which may suggest that as markets get more clarity over time, the effects of complexity wear out and the intentional policy rate takes more of an effect.

Tables 5.3 and 5.4 below show the importance of policy shocks to the bond markets as well as to inflation and output variables. Again, we found evidence that innovations in all three monetary policy variables increasingly explained variations in the bond markets with the effects on the shorter-term corporate bonds being the most significant. We found that our policy variables were up to 30 times more likely to impact corporate bond indices than government bonds. As much as 62% of the variations on the six-month SGI bond index was explained by the combination of policy variables by the 24th month. In terms of how important each of the policy variables were in explaining variations in the bond market, we found consistent evidence that optimism shocks accounted for the largest variations in the bond indices in the first few months but this fell over time and the ISSR became the dominant influence on variations by the 24th month, sometimes explaining up to 95% of policy variations, as with the 10-year government bonds.

Similarly, with inflation and output variables, the combined policy variables tended to grow in influence over the period and generally accounted for between 5% and 10% of all variations by the 24th month. We found interesting evidence that optimism shocks accounted for most of the variation in inflation variables; the exception was that house price indices were instead affected by the ISSR, which is in essence the policy rate. When we turned to real output variables, the ISSR became the most significant policy variable affecting these variables.

Finally, we explored the impact of innovations in our policy variables to a select number of macroeconomic variables. Generally, all our variables showed that innovation in the combined policy variables had an increasing influence in explaining variability over the longer

term and we observed some interesting findings on the relative importance of our policy variables in explaining these variations. We found that over the longer term, the ISSR explained variations in unemployment, weekly earnings and public sector borrowing significantly more than any of the other policy variables, whereas optimism explained variations in retail sales and consumer credit more than any other policy variable. There is some intuition to these findings as these may suggest that optimism drives variables that can respond much quicker to policy changes, such as retail sales and consumer credit, whilst the ISSR impacts variables such as unemployment, earnings and government borrowing, all of which may take longer to evolve.

Table 5.3a: Analysis of the forecast error variance decomposition (FEVD) for bond market variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
SGI 6M BOND	1 month	0.03	0.45	0.02	0.50	0.06	0.89	0.05
	12 months	16.78	0.99	1.33	19.10	0.88	0.05	0.07
	24 months	55.67	3.57	3.65	62.89	0.89	0.06	0.06
SGI 2YR BOND	1 month	0.05	1.03	0.00	1.08	0.05	0.95	0.00
	12 months	7.38	1.01	0.51	8.90	0.83	0.11	0.06
	24 months	37.08	2.29	1.48	40.86	0.91	0.06	0.04
SGI 5YR BOND	1 month	0.09	0.90	0.12	1.11	0.08	0.81	0.11
	12 months	1.31	0.56	0.20	2.07	0.63	0.27	0.10
	24 months	9.34	0.45	0.24	10.02	0.93	0.04	0.02
SGI 10YR BOND	1 month	0.20	0.53	0.20	0.93	0.22	0.57	0.21
	12 months	0.47	1.24	1.00	2.70	0.17	0.46	0.37
	24 months	3.89	1.30	1.36	6.54	0.59	0.20	0.21

Table 5.3b: Analysis of the forecast error variance decomposition (FEVD) for bond market variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
GOVT BONDS 1YR	1 month	0.34	0.76	0.00	1.11	0.31	0.69	0.00
	12 months	2.11	0.75	0.45	3.32	0.64	0.23	0.14
	24 months	1.58	0.68	0.64	2.90	0.55	0.24	0.22
GOVT BONDS 3YR	1 month	0.09	0.53	0.03	0.65	0.14	0.81	0.05
	12 months	0.45	0.10	0.15	0.69	0.65	0.14	0.21
	24 months	0.32	0.06	0.22	0.60	0.53	0.10	0.37
GOVT BONDS 5YR	1 month	0.12	0.75	0.01	0.87	0.13	0.86	0.01
	12 months	0.67	0.29	0.03	0.99	0.68	0.29	0.03
	24 months	0.60	0.23	0.04	0.87	0.69	0.26	0.05
GOVT BONDS 10YR	1 month	0.37	0.35	0.01	0.73	0.51	0.48	0.01
	12 months	4.08	0.20	0.13	4.41	0.93	0.04	0.03
	24 months	6.82	0.18	0.15	7.15	0.95	0.03	0.02

Table 5.4a: Analysis of the forecast error variance decomposition (FEVD) for inflation variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
UK RPI	1 month	2.62	3.49	0.05	6.16	0.43	0.57	0.01
	12 months	3.75	4.54	0.13	8.41	0.45	0.54	0.02
	24 months	4.19	4.53	0.13	8.84	0.47	0.51	0.01
UK HOUSE PRICE INDEX	1 month	0.46	0.01	0.24	0.71	0.65	0.02	0.33
	12 months	4.43	1.08	3.70	9.21	0.48	0.12	0.40
	24 months	3.96	1.17	4.17	9.30	0.43	0.13	0.45
UK CPI	1 month	0.44	2.74	0.02	3.20	0.14	0.86	0.01
	12 months	0.58	3.30	1.01	4.89	0.12	0.67	0.21
	24 months	0.67	3.30	1.01	4.98	0.13	0.66	0.20
UK PPI	1 month	0.00	0.14	0.01	0.15	0.02	0.91	0.07
	12 months	0.14	0.05	0.01	0.20	0.71	0.24	0.05
	24 months	0.73	0.07	0.02	0.81	0.90	0.09	0.02

Table 5.4b: Analysis of the forecast error variance decomposition (FEVD) for output variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
UK CONSTRUCTION OUTPUT	1 month	4.06	0.00	0.36	4.42	0.92	0.00	0.08
	12 months	4.62	0.02	0.42	5.05	0.91	0.00	0.08
	24 months	4.89	0.03	0.41	5.33	0.92	0.00	0.08
UK INDUSTRIAL PRODUCTION	1 month	0.56	0.30	1.42	2.28	0.25	0.13	0.62
	12 months	0.69	1.48	1.48	3.65	0.19	0.41	0.40
	24 months	0.72	1.49	1.48	3.68	0.20	0.40	0.40
UK INDEX OF SERVICES	1 month	0.83	0.83	0.03	1.69	0.49	0.49	0.02
	12 months	1.49	1.16	0.34	2.98	0.50	0.39	0.11
	24 months	1.60	1.16	0.34	3.10	0.52	0.37	0.11
UK MANUFACTURING	1 month	1.73	0.00	2.50	4.23	0.41	0.00	0.59
	12 months	2.17	0.16	2.74	5.08	0.43	0.03	0.54
	24 months	2.22	0.17	2.74	5.12	0.43	0.03	0.53

Table 5.5: Analysis of the forecast error variance decomposition (FEVD) for other select macroeconomic variables

Horizon		Forecast error variance decomposition (FEVD) in %				Share of monetary shocks		
		ISSR	Optimism	Complexity	Total	ISSR	Optimism	Complexity
UK UNEMPLOYMENT	1 month	0.85	0.00	0.39	1.24	0.69	0.00	0.31
	12 months	1.84	0.02	1.52	3.38	0.55	0.01	0.45
	24 months	5.30	0.14	1.63	7.07	0.75	0.02	0.23
UK AVERAGE WEEKLY EARNINGS	1 month	0.01	0.06	0.00	0.08	0.13	0.84	0.03
	12 months	0.50	1.31	0.26	2.08	0.24	0.63	0.13
	24 months	3.44	1.99	0.34	5.76	0.60	0.34	0.06
UK RETAIL SALES	1 month	0.01	0.01	0.83	0.84	0.01	0.01	0.98
	12 months	0.08	1.75	0.51	2.34	0.03	0.75	0.22
	24 months	0.25	2.03	0.46	2.74	0.09	0.74	0.17
UK BUSINESS INVESTMENT	1 month	0.03	0.01	1.83	1.88	0.02	0.01	0.98
	12 months	0.36	0.03	2.73	3.11	0.11	0.01	0.88
	24 months	0.66	0.04	2.72	3.41	0.19	0.01	0.80
UK CONSUMER CREDIT SUPPLIED	1 month	0.01	0.17	1.82	2.00	0.01	0.09	0.91
	12 months	0.41	0.18	3.10	3.69	0.11	0.05	0.84
	24 months	1.74	0.15	3.11	5.00	0.35	0.03	0.62
PSNCR NET BORROWING	1 month	0.20	0.66	0.14	0.99	0.20	0.66	0.14
	12 months	15.00	2.42	2.75	20.18	0.74	0.12	0.14
	24 months	23.41	2.60	2.46	28.47	0.82	0.09	0.09

5.5 Conclusion

Having previously explored how macroeconomic conditions drive the complexity and tone of central bank communication, this chapter goes on to explore the effects of central bank communication on certain macroeconomic and financial market variables. The chapter uses a more traditional FAVAR model which has been used to evaluate macroeconomic policy shocks but incorporates two dimensions of communication, namely complexity and optimism, into the traditional FAVAR model. We limited our analysis of central bank communication to MPC minutes and explored whether these dimensions of communication transmit shocks to the financial and macroeconomic environment. We also included a policy variable into our FAVAR model to control for changes in the macroeconomic and financial environment that may be driven by the BoE's policy rate. Given the period that we evaluated in which the BoE policy rate hit the zero lower bound, we used the international shadow short rate (ISSR) developed by Kripnner (2015) as a proxy measure of the policy rate.

We evaluated the effects of each of the policy variables on other policy variables as well as on the various macroeconomic and financial market variables that we explored. In our first analysis, our result suggested that shocks to the ISSR would drive down optimism and complexity over the short to medium term and also drive down returns in the currency and stock markets over the longer term. Bond yield tended to respond to policy rate shocks in different ways depending on whether the bonds were corporate bonds or government bonds. Shocks to policy rate tend to persistently drive up yields over the medium to longer term (six months and beyond) whilst policy rate shocks tend to drive down government bond yields in the short term only. Some of these findings, especially the reaction of financial markets and corporate bond yields, are consistent with previous work that has explored policy shocks as well as with economic theory. Most of the inflationary and output variables we explored also showed evidence that shocks to the policy rate slowed down measures of inflation and economic activity such as the CPI, RPI, house prices, construction output and industrial production over the medium to long term.

Next, we found that optimism shocks had limited impact on other policy variables but had a significant impact on the currency and stock markets as well as on the other macroeconomic variables which we explored. We noticed that overall, following shocks to optimism in the BoE's communication, inflation fell, output fell, stock market returns fell and the pound rose in value. We found further evidence that optimism shocks reduced credit availability, the money supply and retail sales as well as earnings. Finally, government bond yields also tended to rise in response to optimism shocks. These results seem to mimic

responses to a traditional interest rate shock in a way that is consistent with contractionary economic policy, as summarised in Sims (1992). The intuition here is that with increased optimism in policy communication, individuals and firms expect a rise in interest rates and they respond by making economic decisions in line with this expectation.

Subsequently, we went beyond tone and explored how shocks to complexity of communication impacted on our macroeconomic and financial variables of interest. We noticed that shocks to complexity had no impact on the ISSR but tended to sharply drive down optimism in the immediate term. Generally, we observed that shocks to clarity tended to reduce inflationary pressures, implying that less clarity tended to drive down inflationary pressures. The perception here is that when markets are unclear about the direction of policy from the central bank, they would hold back on spending and consumption, which will lead to reduced inflation. Similarly, we found that clarity shocks tended to cause significant stock and currency market declines. The reasoning here is that if the bank is perceived to have more information and financial market participants look to the bank for clarity, where the bank becomes more unclear about its policy decision, the financial markets react with a selloff of assets that will then lead to a stock and currency market decline. Although bond yields also fell following shocks to clarity, the dynamics of the bond markets are different from the stock and currency markets. We argue that a fall in bond yield here may be driven by the declining inflationary pressures that follow clarity shocks. This is because bond investors tend to hold on to bond coupon payments when they anticipate inflation will fall as this will push down yield values (via increasing demand and bond prices). Lastly, we found mixed evidence on the effects of clarity shocks on output and credit availability variables.

Finally, to evaluate the comparative importance of each of the individual policy shocks on our macroeconomic and financial variables, we carried out forecast error variance decomposition (FEVD) analysis over a 24-month period. We found that in all of our analyses, the combined effects of our policy variables (i.e. ISSR, optimism and tone) tended to consistently explain more of the variation in the financial and macroeconomic variables of interest over time. For instance, up to 62% of the variations in the short-term corporate bond SGI index was explained by a combination of the policy variables by the 24-month mark. Generally, the impacts of the policy variables were highest for the bond market, followed by the stock market and public sector government borrowing, whose variations were explained by the combined policy variables up to 29% and 26% respectively. Other variables explored tended to have between 2% and 10% of their variations explained by the combined policy variables.

For additional clarity, we also explored the relative importance of individual policy variables within the combined policy effects. The evidence suggested that ISSR and optimism shocks were the key drivers of variability in the currency market over the long term while complexity shocks overwhelmingly explained variations in the stock markets in the immediate period, although ISSR also became important in the long run. Given that as much as 70% to 80% of all policy shocks was accounted for by shocks to complexity of communication in the immediate period, we suggest that complexity significantly impacts financial markets initially but as markets get more clarity over time, the effects of complexity wear out and the intentional policy rate takes more of an effect. For the bond markets, we found consistent evidence that optimism shocks account for the largest variations in the bond indices in the first few months but this falls over time and the ISSR becomes the dominant influence on variations by the 24th month, sometimes explaining up to 95% of policy variations as with the 10-year government bonds.

Similarly, optimism shocks accounted for most of the variation in inflation variables with the exception of house price indices, which were instead affected by the ISSR. When we turned to real output variables, the ISSR became the most significant policy variable, explaining variations in unemployment, weekly earnings and public sector borrowing significantly more than any of the other policy variables.

Overall, our key finding in this section is that optimism shocks tend to have a significant impact on macroeconomic and financial market variables in a way that is similar to a contractionary policy. In addition to this, we found that optimism shocks significantly contributed to explaining variations in the key macroeconomic and financial variables in the near term, particularly in the currency and bond markets as well as with inflation variables. There is some intuition to these findings as these may suggest that optimism drives variables that respond much more quickly to policy changes, such as the currency and stock market variables, as well as retail sales and consumer credit. Importantly, we also found that shocks to complexity of communication overwhelmingly explained the variations in the stock market in the immediate term when compared to policy rate (ISSR) shocks and optimism shocks. Given that an increasing number of central banks are turning to communication as an alternative policy tool to drive short-term expectations and there is still no consensus on what dimensions of communication to measure nor how these may quantitatively impact policy as interest rates would, our results provide interesting findings to help explain possible solutions. At the zero lower bound, where lowering interest rates further may not be feasible, these dimensions of

communication may become a viable policy tool through which the central bank may drive policy.

CHAPTER SIX

6.0 CENTRAL BANK COMMUNICATION AND FINANCIAL MARKET VOLATILITY

6.1 Introduction

This chapter evaluates the effects of central bank communication on financial market volatility. In the previous chapters, we explored the back end of what influences communication in the first place and how communication shocks impact macroeconomic variables. To get a more complete narrative of the potential role of communication as a central bank policy tool, however, it is useful to explore how communication affects volatility in financial markets. Blinder (2008) highlights that since central bank communication has become increasingly important as a policy tool and that in order to drive transparency, there is a need to ensure that communication ‘reduces noise’ and ‘creates news’. Rosa (2011) evaluated the effect of the US Fed’s decisions and statements on stock prices and volatility and argued that as much as 90% of the explainable variation in the S&P 500 is due to the surprise components of the Fed’s communication. It is in this context that exploring volatility in financial markets becomes crucial. Our key research question in this chapter, therefore, is whether monetary policy communication released by the BoE via MPC minute reduces noise (volatility) in the financial markets.

Although there is extant literature on the extent to which monetary policy as a whole affects asset price volatility (e.g. see Rigobon and Sack 2004; Reeves and Sawicki 2007), these studies have mostly relied on short-term interest rates driving asset prices. At the zero lower bound and given the growing importance of communication and forward guidance as a policy tool, these studies therefore are limited in the sense that short-term interest changes may no longer be the dominant policy tool used by a central bank. In light of this shortcoming, some other studies have attempted to look beyond the interest rate changing behaviour of central banks to explore the impact of communication on the financial market. Gurkaynak et al. (2005), for instance, explored a two-factor scenario where the effects of both the federal fund rate and communication about future policy by the FOMC on financial markets were analysed. Their work provides evidence that communication, when used along with federal funds rate changes, has a much greater effect on asset prices and the longer-term treasury yield. Ehrmann and Fratzscher (2009) found further evidence to support Gurkaynak et al.’s work and showed that

communication about policy via statements had a greater effect on financial market volatility than policy rate changes.

A potential limitation of some of these initial works that explore the impact of central bank communication on financial market volatility is that they do so by simply exploring financial market volatility on the day the communication is made without an analysis of the content of the communications. Kohn and Sack (2003), for instance, found that statements released by the FOMC and congressional testimonies by the then FOMC chairman, Alan Greenspan, did increase volatility in the financial variables they explored. Some other studies such as Hendry (2012) partially explore the content of central bank communication by grouping these communications into themes based on their contents, such as oil price communication, Canadian dollar communication, GDP communication, labour market communication, balance of risk communication and so on. They then evaluate the effects of the release of such communications on financial market volatility. Their findings present mixed results, with certain communication such as oil price communication, Canadian dollar communication and inflation projection all leading to increased volatility in the short-term bond market whilst other communication related to GDP, labour and investment all led to reduced volatility in the short-term bond market.

Our work in this chapter is more closely related to that of Born et al. (2014), who estimated the effects of financial stability reports (FSR) and speeches by 37 central banks on financial markets using content analysis of these communications, as well as Jansen (2011b), who estimated the effects of Humphrey-Hawking statements on financial market volatility, also using content analysis. Similar to our work, Born et al. (2014) used Diction to extract optimism scores from FSRs and speeches. Our work is nonetheless unique in the sense that, rather than examining FSRs and speeches, we explore monetary policy communications that are created following deliberation of policy and are carefully crafted to provide information to financial market participants. Our work focuses more on policy communication creating noise or otherwise providing news rather than on its role in financial stability. The need to analyse the content of such policy communication when exploring volatility becomes more necessary given our previous findings that the clarity and tone of central bank communication are affected by the macroeconomic conditions in which the communications are made. It is therefore important to evaluate if these time-varying characteristics of central bank clarity and tone go on to impact financial market volatility and this chapter goes on to analyse that.

This chapter addresses our research question (iv) on whether monetary policy communication via MPC minutes affects volatility in financial markets. We use an E-GARCH

methodology to test the impact of our communication variables on the conditional variance of our financial market variables. In line with the literature, which suggests that more complex communication calms financial markets (e.g. see Geraats 2007, Ehrmann and Fratzcher (2007c), we hypothesise that less complexity and more optimism in monetary policy communication should reduce volatility in the financial markets. Therefore, our hypothesis is that the conditional variance of our financial market variables should be positive. We do not propose an *a priori* for the response of financial market volatility to changes in optimism. Contrary to our expectations, our results showed that complexity of communication had a largely insignificant effect on the volatility of financial market; however, we found that increased optimism reduced the volatility of financial markets. The next sections of this chapter elaborate further on our expectations as underpinned by the literature and we detail the methodology used to obtain these results as well as our analyses.

6.2 Complexity and tone of communication and financial market volatility

The role of complexity of communication in central bank policy making has been well emphasised in this work. Complexity becomes particularly essential as central bank transparency and accountability grow, especially among inflation-targeting central banks. There is an emerging strand of literature that argues that central banks do indeed vary the complexity of their communication and our chapter on what influences the complexity of central bank communication presents further evidence in this regard. Bulir et al. (2013) suggest that central banks have the incentive to vary the complexity of their communication to suit their policy objectives and some of our findings above show that difficult macroeconomic conditions may sometimes increase the complexity with which the BoE communicates. The important question here is to what extent does such complexity or otherwise in communication go on to affect financial market volatility.

There are opposing views on how complexity of communication may go on to impact financial market volatility. Geraats (2007) argues that financial markets respond strongest to signals that are perceived to be clear. She suggest that central banks can mute the volatility of financial markets by creating a perception of ambiguity.

In contrast, Jansen (2011b), exploring Humphrey-Hawkings statements of US Fed Chairs, found that it is clearer communications that mute volatility whilst unclear communication increases volatility. Born et al. (2014) also present evidence that FSRs reduce noise and create news in the financial markets. In addition, Ehrmann and Fratzcher (2007c)

argue that additional clarity provided by press conferences following a policy decision reduces volatility in financial markets. There is some reasoning to these latter findings in the sense that one would assume that clarity should reduce financial market volatility by allowing economic agents to make informed financial decisions from the clear information provided by the bank and vice versa. Our hypothesis that reduced complexity of communication should reduce financial market volatility is thus derived from the foregoing.

Although the literature around clarity is more developed, the literature on central bank tone, on the other hand, is relatively less developed in terms of the exploration of the effects of policy communication on financial markets. The problem is that several dimensions of tone can be explored and there is generally no consensus on what specific dimension of tone financial markets respond to. The argument for exploring the tone of central bank communication is similar to that of clarity and relates to the need for central banks to be transparent and accountable. If indeed central banks strive for optimal transparency, as the literature suggests (e.g. see Eijffinger and Geraats 2006), then understanding the details of every central bank communication becomes important. Where there exists a ‘cacophony of voices’, a phenomenon which Blinder et al. (2008) define as central bank policy makers speaking with different voices (or tones) on the same matter, then understanding the collective tone of policy communication becomes important. Tone is also important because, unlike clarity, which is subject to the individual vocabulary of the writer, the same tone can be captured across various vocabulary levels.

Most of the previous research done on the effects of communication tone on financial market volatility have mainly focused on corporate tone and stock price volatility (e.g. see Price et al. 2012 for a survey). These studies often look at the positive or negative tone of managers, the incentives behind this and the eventual effects on stock price volatility. Arslan-Ayaydin et al. (2015) argue that managers have an incentive to speak with less optimism in a manner that is consistent with the so-called leverage effect of negative news on volatility, as first presented by the works of Black (1976). The idea is that less optimistic communication leads to a negative response of the stock price which then has the effect of increasing the debt/equity leverage ratio and the probability of default and finally increased volatility.

Although these channels are relatively well defined for corporate organisations, the incentive for central banks to vary tone with the effect of influencing volatility is less clear. Overall, there is limited evidence on the effects of central bank communication on financial market volatility; nonetheless, a few studies have attempted to explore the effect of optimism tone on volatility. Born et al. (2012) explored the effects of financial stability reports (FSRs)

on the financial markets of a select number of emerging market economies. Similar to our analysis, they used Diction to capture the optimism scores of FSR communication and speeches and their results provide evidence that more optimistic communication tends to reduce volatility across the stock indices, the three-month interest rate and the US dollar spot exchange rates for these countries. These results corroborate their earlier findings (Born et al. 2011) which examined a broader range of 35 countries and also showed that FSR communications reduced financial market volatility especially when the contents of the FSRs were more optimistic. Using communication from the ECB, Schmeling and Wagner (2016) also showed the effect of optimistic tone on option-implied volatility of stock prices. Their findings suggest that more positive tone of communication leads to decreasing volatility expectations. Our hypotheses that more optimistic and more certain communication should lead to reduced volatility in financial markets are largely derived from the foregoing.

6.3 Methodology and data

To evaluate the effects of BoE monetary policy communications on the volatility of financial market variables of interest, we employ Nelson's (1991) exponential GARCH (E-GARCH) model to explore how specific dimensions of communication from the BoE affects the conditional mean and conditional variance of important financial markets of interest

Our volatility analysis focuses on three financial markets of interest, which are the stock markets, the foreign exchange market and the bond markets. Our rationale for selecting these markets is mainly driven by the focus the BoE places on these markets in its communication as well as the interest in these markets by economic agents. Specifically, in both MPC minutes and inflation reports, the BoE has sections dedicated to its analysis of these key financial markets. For the financial markets, we explored returns to four stock market indices, namely the FTSE100, the FTSE 250, the FTSE 350 and the FTSE All Share. These were analysed separately to capture the effects of the size of the constituent companies, i.e. FTSE 100 capturing the largest companies whilst the FTSE All Share captures a broader range of companies including relatively smaller companies. For the currency markets, we focused on the value of the pound (GBP) relative to the US dollar (USD), the euro (EUR), the Japanese yen (JPY), the Canadian dollar (CAD) and the Australian dollar (AUD). Finally, for the bond market, we focus on UK Government bond yields with specific reference to the one-year, three-year, five-year and ten-year generic note bond yields as well as the more corporate bond aligned six-month, two-year, five-year and ten-year Société Générale Index (SGI bond index).

The dimensions of communication we explored were similar to those in previous parts of this study, mainly covering the complexity and tone of communication. Consistent with other parts of our work, we explored complexity using the Flesch-Kincaid Grade Level. The measure estimates the amount of years of formal education required to understand a text, with higher values implying more complexity and vice versa. The Diction software programme, which is a widely used piece of content analysis software, was used to quantify the dimensions of tone we sought to evaluate, namely optimism and uncertainty from the BoE's communication.

Our econometric approach used in modelling the effects of the above dimensions of central bank communication on financial markets closely follows the works of Born et al. (2012) and uses an E-GARCH (1,1) model. Specifically, if we represent the variable of interest as $x_{i,t}$ and its lag as $x_{i,t-1}$, the conditional mean equation will be given as:

$$x_{i,t} = \alpha + \beta \text{Com}_t^i + \gamma x_{i,t-1} + \varepsilon_{i,t} \quad \dots (6.1)$$

Where Com_t^i captures the dimension of communication we are interested in capturing (i.e. clarity or tone – optimism, uncertainty, activity) and $\varepsilon_{i,t} \sim (0, h_{i,t})$.

The conditional variance for our E-GARCH (1,1) can be expressed as:

$$\log h_{it} = \psi + \omega \left(\left| \frac{\varepsilon_{i,t-1}}{\sqrt{h_{i,t-1}}} \right| - \sqrt{2/\pi} \right) + \vartheta \left(\frac{\varepsilon_{i,t-1}}{\sqrt{h_{i,t-1}}} \right) + \phi \log(h_{i,t-1}) + \lambda \text{Com}_t^i + \theta \text{IVI}_t \quad \dots (6.2)$$

Where $h_{i,t}$ is the conditional variance of $x_{i,t}$, and $\varepsilon_{i,t-1}$ are past innovations. Com_t^i and IVI_t are exogenous variables that are incorporated into the conditional variance equation to capture the specific volatility movements caused by each of these variables. Specifically, Com_t^i represents the communication variable of interest while IVI_t is the FTSE implied volatility index which measures the implied volatility of the FTSE 100 over a 30-day period. The advantage of employing an E-GARCH model in our analysis is that we can capture both asymmetric and magnitude effects of shocks to our financial market variables. This implies that both positive and negative shocks may have different effects on the volatility of our financial market variables and we did not have to impose a requirement for the coefficient in the conditional variance equation to be positive. Section 6.5 below details our results.

6.4 Results

As detailed above, our analysis seeks to explore the effects of two broad dimensions of the BoE's communication, namely complexity and tone (optimism) on the volatility of financial markets. Using an E-GARCH (1,1) model we explored if the complexity and optimism in the BoE's communication specifically affects the stock, currency and bond markets. Our result tables highlight three main coefficients, namely the coefficient (β) from the mean equation, the coefficient (λ) from the variance equation and the coefficient (θ) also from the variance equation. β measures the response of the financial market variables to unit changes in communication while (λ) and (θ) capture the effects of communication variables and the implied volatility index, respectively, on the volatility of the financial market variables. As highlighted above, we included the implied volatility index in our variance equation to control for volatility in the financial market that is not caused by communication; therefore, this allowed us to capture the isolated effects of communication on volatility. The dependent variable in our mean equations is measured in first differences, therefore a 0.01 value for the coefficient of the communication variable will signal a 1% change in percentage return. Given that our main aim in this chapter is to check whether complexity and tone have an impact on volatility, we focus mostly on the evaluation of the effects of λ . For volatility analysis, our observation is focused more on the sign of the coefficient, i.e. whether volatility was increased or reduced.

6.4.1 Effects of central bank complexity on financial market volatility

In this section, we explore the effects of complexity of MPC minutes on the volatility of the stock markets as measured by the key market indices (FTSE 100, FTSE 250, FTSE 250 and the FTSE All Share), the currency markets as measured by the pound's value relative to four major currencies (the CHF, JPY, EUR, and USD) and the bond markets as measured by a number of UK government bond yields as well as the Société Générale UK Bond Index. Tables 6.1 to 6.3 below show the summary of our analysis of the effects of complexity on financial market volatility.

Table 6.1 - Effects of central bank complexity on stock market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
FTSE 100	0.046 (2.10)	0.08 (0.14)	0.036*** (0.0082)	1.95
FTSE 250	0.029 (1.75)	-0.16*** (0.050)	0.11* (0.068)	1.84
FTSE 350	0.028 (0.96)	0.077 (0.11)	0.045*** (0.010)	1.93
FTSE All Share	0.027 (0.92)	0.060 (0.11)	0.047*** (0.011)	1.92

With the stock market in table 6.1 above, we found that only the FTSE 250's volatility was significantly affected by the clarity of the BoE's communication. The evidence suggests that more complexity leads to reduced volatility in the FTSE 250 index. This finding is in line with Greenspan's approach that seems to suggest that ambiguity in communication mutes market volatility.

Table 6.2 - Effects of central bank complexity on currency market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
GBP_CHF	0.0073*** (0.00072)	0.37** (0.11)	0.020*** (0.0073)	2.22
GBP_EUR	0.0008 (0.0014)	0.00145 (0.0092)	0.088*** (0.0025)	2.12
GBP_JPY	0.0022 (0.0095)	-0.00014 (0.00037)	-0.0041 (0.0029)	1.90
GBP_USD	-0.0011 (0.0011)	-0.015 (0.013)	0.032*** (0.0064)	1.85

As Geraats (2007) identified, the reason for this is that financial markets tend to react to communication that they perceive to be clear. Therefore, when signals coming from the central bank seem unclear, market participants will hold on to their assets until they perceive clearer signals. As expected, increasing implied volatility in the stock market seems to increase volatility in all the stock market indices explored.

Table 6.2 above shows the impact of complexity of communication on the volatility of a number of currency market pairs. Once more, we found evidence of limited impact on most of the currency pairs with the exception of the GBP_CHF currency pair. The evidence suggests that increased complexity seemed to increase volatility in the GBP_CHF currency market pair. Similar to the stock markets, implied volatility in the stock markets consistently increased volatility in the currency markets as well.

Table 6.3 - Effects of central bank complexity on bond market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
GOVT BONDS 1YR	-0.0075 (0.011)	-0.001 (0.0018)	-0.00036 (0.0023)	1.31
GOVT BONDS 3YR	-0.0062 (0.017)	0.000942 (0.002859)	0.0034 (0.012)	1.47
GOVT BONDS 5YR	-0.0026 (0.019)	0.00087 (0.0029)	0.0034 (0.016)	1.64
GOVT BONDS 10YR	0.0090 (0.018)	-0.00015 (0.0031)	0.00018 (0.00021)	1.93
SGI BONDS 10YR	0.15 (0.11)	-0.0022 (0.013)	-0.00051 (0.0008)	1.84
SGI BOND 5YR	0.16 (0.68)	0.99 (2.92)	0.054 (0.19)	1.52
SGI BOND 2YR	-0.10 (0.25)	-0.14** (0.06)	0.0092** (0.0045)	1.26
SGI BOND 6M	-0.092*** (0.033)	-0.14 (0.089)	-0.0013 (0.0041)	0.405730

As we proposed earlier, one would expect that the effect of increased clarity in the BoE's communication is that financial market participants are able to make informed decisions that would hence reduce financial market volatility. This result, therefore, aligns with our expectations that more complexity may tend towards increased volatility in financial markets. These results are also consistent with the findings of Ehrmann and Fratzcher (2007c), who suggest that financial market volatility tends to reduce when central banks communicate more clearly.

Finally, we evaluated the impact of complexity of communication on the volatility of our bond market variables of interest. Similar to the stock and currency markets, complexity of communication seemed to have limited impact on the volatility of bond markets. We found that only the volatility of the SGI Bond index with two years to maturity was impacted by complexity of communication. The reaction to this is similar to the stock market result, where increasing complexity seemed to reduce volatility. Overall, our analysis of the impact of complexity on the stock, currency and bond market provides limited evidence that complexity significantly impacts on the volatility of these markets.

6.4.2 Effects of central bank optimism on stock market volatility

Similar to our analysis of complexity above, we evaluated the impact of changes in the level of optimism in central bank communication on the same stock, currency and bond market variables. Tables 6.4 to 6.7 below highlight our results.

Table 6.4 - Effects of central bank optimism on stock market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
FTSE 100	0.21 (0.14)	-0.18* (0.10)	0.023*** (0.008)	1.94
FTSE 250	0.30 (0.22)	-0.081 (0.091)	0.074*** (0.015)	1.81
FTSE 350	0.084*** (0.009)	-0.031*** (0.0069)	0.14** (0.067)	1.97
FTSE All Share	-0.0061*** (0.002247)	-0.00024 (0.00027)	0.034*** (0.0012)	1.30

Figure 6.4 above shows the results of the effects of changing optimism on the volatility of the stock market variables. We found more consistent evidence that optimism impacted the volatility of stock market significantly more than complexity did. Both the FTSE 100 and the FTSE 350 indices provide evidence that rising optimism reduces volatility. These findings are consistent with our expectations as well as with the findings by Arslan-Ayaydin et al. (2015) on the relationship between optimism and company stock prices and the findings by Born et al. (2012) that increased optimism in central bank communication reduces financial market volatility.

Table 6.5 - Effects of central bank optimism on currency market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
GBP_CHF	-0.0036 (0.0023)	-0.14** (0.064)	0.018*** (0.0052)	2.16
GBP_EUR	-0.00055 (0.0011)	-0.000258 (0.0072)	0.013* (0.0079)	1.82
GBP_JPY	0.061 (0.042)	-0.024** (0.0095)	0.0026 (0.0059)	1.94
GBP_USD	-0.0011 (0.0018)	0.11 (0.085)	0.035*** (0.012)	1.87

The results for stock market were also consistent with those for the currency market pairs shown in table 6.5 above, with the exception of the GBP_EUR and GBP_USD currency pairs which did not show evidence of have an impact on volatility. As expected, rising implied volatility in the stock market consistently increased volatility in the majority of stock market indices and currency pairs.

Table 6.6 - Effects of central bank optimism on bond market volatility

Variable	Mean (β)	Volatility (λ) Clarity	Volatility (θ) IVI	Durbin Watson
GOVT BONDS 1YR	0.018** (0.0081)	-0.02 (0.03)	-0.0012 (0.002)	1.35
GOVT BONDS 3YR	0.029** (0.012)	-0.048 (0.037)	0.0011 (0.0024)	1.54
GOVT BONDS 5YR	0.031** (0.014)	-0.062 (0.043)	0.0006 (0.0024)	1.71
GOVT BONDS 10YR	0.027** (0.013)	-0.0032 (0.0021)	0.0079 (0.0089)	1.99
SGI BONDS 10YR	-0.017** (0.0067)	-0.0084 (0.014)	-0.00077 (0.00073)	1.88
SGI BOND 5YR	-0.12** (0.049)	-0.011 (0.021)	0.109013 (0.018)	1.58
SGI BOND 2YR	-0.038 (0.17)	-0.019 (0.062)	0.0045 (0.004)	1.25
SGI BOND 6M	-0.038724 (0.025)	-0.034 (0.041)	-0.0011 (0.0044)	0.39

Finally, figure 6.6 above shows the impact of optimism on the volatility of bond market yields. We found no evidence that either optimism or even implied volatility in stock markets had an impact on the volatility of bond market yields. It is worth noting, however, that optimism had a significant effect on government bond yields, with yield rising between 2% and 3% following unit increases in optimism (as measured by Diction). The conclusion here is that optimism is important in interpreting bond market yields but not in bond market volatility.

6.5 Investigating the existence of reverse causation in our models

Given that our results in chapter four above suggest that communication is impacted by currency market returns and in some cases by the financial markets through our financial crisis variable, it is therefore important to explore the potential of reverse causation in our models. To do this, we examined whether volatility of currency and stock markets had an impact on communication. Our approach was to regress our two main measures of communication (i.e. complexity and optimism) on their own lags and on the lagged volatility of currency and financial market variables measured as the squared residuals from the E-GARCH equations above. Our intuition was that if the values of the volatility measures are insignificant, we can conclude that although stock and currency returns do impact communication, volatilities in these returns do not. In addition to regressing the lagged communication variables on volatility, we also included the volatility measures into our original model in equation 4.1 above to test whether the volatility variables had any impact in our original models.

Equation 6.3 below represents our initial analysis, which examines the relationship between communication variables and the lagged volatility from the currency and financial markets volatility equations.

$$C_{it} = \alpha + C_{it-1} + \xi_{1t} + \xi_{2t} + \varepsilon_{i,t} \quad \dots(6.3)$$

Where C_{it} is the communication variable of interest (complexity or optimism); ξ_{1t} is the lagged volatility of the currency market measured as the squared residuals from the GBP_USD estimation in the E-GARCH equations above; ξ_{2t} is the lagged volatility of the stock market measured as the squared residuals from the FTSE all share estimation in the E-GARCH equations above. $\varepsilon_{i,t}$ is the error term. Table 6.7 below shows a summary of our results.

Table 6.7 - Effects of lagged volatility on communication variables

	<i>Effects of lagged volatility on complexity</i>	<i>Effects of lagged volatility on optimism</i>
<i>Constant (α)</i>	7.54*** (0.66)	34.11*** (3.63)
<i>Lagged communication (C_{it-1})</i>	0.40*** (0.05)	0.33*** (0.073)
<i>Lagged currency market volatility (ξ_{it})</i>	0.19 (1.35)	-0.42 (1.79)
<i>Lagged financial market volatility (ξ_{it})</i>	.01233 (0.51)	1.27 (0.94)
R squared	0.161439	0.116877
Standard error of regression	0.785244	1.208525
Durbin-Watson	2.53	2.106983

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis

The results above show that both of the coefficients measuring the lagged volatility in the currency market and financial markets are insignificant. Therefore, this may suggest that volatility of currency financial markets does not impact communication and therefore there is no evidence of reverse causation in the ways in which our models are structured. To further support this argument, we input the lagged volatility measures used above into our original equation 4.1 to test whether these lagged volatility measures were significant in our original equation. Similar to our analysis above, we found no evidence of either the lagged volatility in currency or financial markets impacting both complexity and optimism. The results of this analysis are presented in appendix C.

6.6 Conclusion

This chapter explored the effects of the BoE's MPC communication (via its minutes) on financial market volatility. The chapter addresses our research question (iv) as to whether volatility of financial market variables is impacted by complexity and tone of communication. Specifically, we explored how the complexity and optimism in the MPC minutes affects the volatility of the stock markets, the currency markets and the bond markets. Our results seem to suggest that overall, complexity of communication has very limited effects on the volatility of

the stock, currency and bond markets. We did find some evidence of complexity impacting financial market variables but these are not consistent enough to depict a clear picture. For example, the FTSE 250 and the SGI 2yr Bond index both show evidence of reduced volatility as complexity of communication increased while the GBP_CHF currency pair showed evidence of reduced volatility when complexity of communication increased.

Our most significant finding in this section is that rising optimism in communication does indeed reduce volatility in the stock market and currency market. We found that a significant number of our stock market and currency market variables showed reduced volatility with increased optimism. This result is consistent with our expectations as well as with findings in the literature such as those of Born et al. (2012) who found that rising optimism reduced volatility in financial markets. An alternative argument for this relationship is that increased optimism raises the incentive for investors to hold on to stock and currency market assets thereby reducing uncertainty and, subsequently, volatility in these markets. Some of the evidence from the corporate sector also corroborates the idea that optimism in CEO speeches tended to reduce volatility in the stock prices of the company (e.g. see Li et al. 2008).

Finally, it is worth mentioning that although not central to our research question, we found evidence that rising optimism seemed to consistently increase government bond yields across all maturities, although neither optimism nor complexity had any significant impact on bond market volatility. The conclusion from the above is that bond market volatility is generally not impacted by central bank monetary policy communication.

CHAPTER SEVEN

7.0 Summary and Conclusions

This chapter presents a summary of our work and ties together our research questions, hypotheses, analyses and results. Our work is based on two fundamental premises. First, that given the increasing demands for accountability and transparency, central bank communication may be impacted by the varying macroeconomic conditions in which the communication is made. Second, that central bank communication may also transmit some onward effects to financial and economic variables. Using standard textual analysis software and methodologies, we explored two main dimensions of communication, namely the complexity and the tone of communication, to assess communication released by the Bank of England in the form of monetary policy committee (MPC) minutes and quarterly inflation reports. To this end our work sought to address four specific research questions:

- i. Given the increased need for accountability and transparency by the Bank of England, to what extent has the trend of complexity and tone of the bank's communication changed over our sample period (i.e.1997 to 2015)?
- ii. Are the varying levels of complexity and tone of communication associated with the prevailing macroeconomic conditions in which the communication is made?
- iii. Does central bank communication transmit shocks to key macroeconomic and market variables environment when they are made?
- iv. Does central bank communication significantly impact volatility in financial markets when these communications are made?

We explored a unique communication regime in the BoE's history which covered September 1997, when the bank gained full independence, and July 2015 when the bank significantly changed its communication practices in response to recommendations from the Warsh report (2014). Using standard computerised textual analysis aided by Diction software and the Flesch-Kincaid readability methodology, we captured tone and complexity data for 215 MPC Minutes and 75 Inflation Reports. Chapter three of our work details the textual analysis process used in extracting and obtaining the data used in our analysis.

In exploring these aspects of the BoE's communications, our work sought to contribute to the literature in three main ways. First, by exploring whether the bank's clarity and tone are influenced by the macroeconomic conditions during which the communication is made, we are able to extend the burgeoning literature on what drives central bank communication in the first

place and we expand on the research in this area, building on studies such as Bulir et al. (2013). Secondly, by exploring whether communication shocks are transmitted to key macroeconomic variables using the FAVAR model, we are able to determine how communication shocks impact the macro economy and provide a possible framework for communication as a policy tool. Finally, by exploring volatility transmission from central bank communication to the financial markets, we are able to determine how the clarity and tone used in communication transmit volatility onto the financial markets. A summary of our research questions, expected findings and thesis findings are summarised in Appendix E below.

With regard to our first two research questions, our expectations were that given the increasing demands on accountability and transparency and in line with recent findings in the literature, the BoE's communication should be clearer and less complex over our sample period. We also followed the argument that if the BoE is faced with more challenging macroeconomic conditions, which we mainly defined as a significant rise in inflation accompanied by widening inflation gaps and falling sterling values, it may tend to communicate with more complexity, less optimism and less certainty. We noted that this behaviour may be as a result of the BoE itself being unclear and uncertain about the macroeconomic headwinds that it faced but the need for accountability and transparency required it to communicate those unclear and uncertain scenarios in its policy documents. In essence, our study therefore sought to test whether central banks conform to this hypothesised behaviour, which can be defined as follows:

- i. Null hypothesis (1)– H_0 : there is no change in the trend of complexity and tone of the BoE's communication over our sample period. (see equation 4.1)

$$H_0: T_{it} = 0$$

$$H_1: T_{it} \neq 0$$

Where T_{it} refers to the trend variable in our model in equation 4.1 above.

- ii. Null hypothesis (2) – H_0 : There is no association between complexity and tone and prevailing macroeconomic conditions (see equation 4.1).

$$H_0: \beta_\pi = \beta_{\pi c} = \beta_{\pi e} = \beta_\gamma = 0$$

$$H_1: H_0 \text{ is not true}$$

Where, π represents the current inflation rate, πc represents the contemporaneous inflation gap, πe represents forward-looking inflation gap and γ represents the pound/dollar exchange rate in equation 4.1 above.

In line with our first research question and hypothesis, we found evidence that the complexity of MPC minutes published by the bank decreased over our sample period. By suggesting that clarity is an important precondition to transparency, this finding is in line with recent suggestions in the literature that central banks are employing every means they can to increase transparency. We did not, however, find evidence of the same decrease in the complexity of inflation reports as our trend variable turns out insignificant. When we explored tone of communication, we found evidence that the level of uncertainty reflected in the bank's inflation reports also reduced, signifying that the bank had grown more assured in its inflation report communications. We did not find evidence of any other trends in the tone of communication reflected in the bank's inflation reports.

We also documented interesting results in line with our second research question and hypothesis above. In this model, our macroeconomic data mainly included variables that captured inflationary pressures and exchange rate pressures, namely inflation rate, the contemporaneous inflation gap, the forward-looking (ex-ante) inflation gap and exchange rate. We further included the financial crisis dummy variable to control for the significant period of the 2008 financial crisis. We then expressed our macroeconomic variables as a function of each of these dimensions of communication. We tested whether there was any association between the communication made and the macroeconomic conditions at the time of making the communication. We found significant evidence to show that macroeconomic conditions had a sizeable impact on the complexity and tone of the bank's communication.

Our core finding in this section of our work is that when the bank is faced with some of the challenging macroeconomic conditions described above, both the complexity of MPC minutes and inflation reports tended to rise significantly. We found that falling pound values tended to impact complexity of communication the most with MPC minutes requiring a further 1.3 years of formal education to comprehend the text and inflation reports requiring 2.5 years of formal education for every unit 10p fall in value of the sterling. Generally, inflationary pressures seemed to be a dominant driver of complexity and tone across both MPC minutes and inflation reports. A rising inflation rate was observed to reduce optimism in MPC minutes

and increase uncertainty in inflation reports. Furthermore, we found consistent evidence that as inflation deviated further from the inflation target both MPC minutes and inflation reports were significantly less optimistic.

We further hypothesised that a transparent central bank may communicate with more complexity, less optimism and more uncertainty if it is indeed faced with a scenario that is more complex. In line with this, these findings may also partly support the notion that the BoE exhibited elements of transparency by largely conforming to this hypothesised behaviour. It may also be useful to explore challenging macroeconomic conditions using the period of the 2008 financial crisis as a sample. To this effect, our work also explored the role that the existence of a financial crisis played in influencing the complexity and tone of communication. In doing this, we found evidence that the 2008 financial crisis significantly increased the level of uncertainty observed in MPC minutes but there seemed to be no impact on other measures of complexity and tone across MPC minutes and inflation reports. This suggests that the bank's complexity and tone of communication were more impacted by changing inflationary and exchange rate environments than by the existence of a full-blown financial crisis.

The next chapter of our work (chapter 5) addressed our research question (iii) and sought to explore the transmission of shocks from communication to select macroeconomic and financial market variables. The chapter used a more traditional FAVAR model which has been used to evaluate macroeconomic policy shocks but incorporated two dimensions of communication, namely complexity and optimism, into the traditional FAVAR model. Here, we limited our analysis of central bank communication to MPC minutes and explored whether these dimensions of communication transmitted shocks to certain financial and macroeconomic variables. To control for the intended effects of policy that may be driven by the bank's policy rate, we included the international shadow short rate (ISSR) developed by Kripnner (2015) as a proxy measure of the policy rate given the presence of the zero lower bound in our sample period.

Our initial analysis explored shocks to the ISSR and found that this drove down returns in the currency and stock markets over the longer term. Bond yield tended to respond to policy rate shocks in different ways depending on whether the bonds were corporate bonds (measured by the SGB bond index) or government bonds. Shocks to ISSR tended to drive up corporate yields persistently over the medium to longer term (six months and beyond) and drive down government bond yield in the short term only. Some of these findings, especially the reaction of financial markets and corporate bond yields are consistent with previous work that has explored policy shocks as well as with economic theory. Most of the inflationary and output

variables we explored also showed evidence that shocks to the policy rate slowed down measures of inflation and economic activity such as the CPI, RPI, house prices, construction output and industrial production over the medium to long term.

Of more interest to our work is the response of these variables to optimism and complexity shocks. First, we noted that overall, following shocks to optimism in the bank's communication, inflation, output and stock market returns all fell and the pound rose in value. We found further evidence that optimism shocks reduced credit availability, the money supply, and retail sales as well as earnings. Finally, government bond yields also tended to rise in response to optimism shocks. These results seem to mimic responses to a traditional interest rate shock in a way that is consistent with contractionary economic policy. We argue that with increased optimism in policy communication, individuals and firms expect interest rates to rise and they respond by making economic decisions in line with this. Next, we explored how shocks to complexity of communication impacts on our macroeconomic and financial variables of interest. Generally, we observed that shocks to complexity tended to reduce inflationary pressures and caused significant stock and currency market declines as well as a fall in bond yields. We found mixed evidence regarding the effects of complexity shocks on output and credit availability variables.

Finally, to evaluate the comparative importance of each of the individual policy shocks on our macroeconomic and financial variables, we carried out forecast error variance decomposition (FEVD) analysis over a 24-month period. We found that in all of our analyses, the combined effects of our policy variables (i.e. ISSR, optimism and tone) tended to consistently explain more of the variation in the financial and macroeconomic variables of interest over time. For instance, up to 62% of the variations in the short-term corporate bond SGI index was explained by a combination of the policy variables by the 24-month mark. Generally, the impacts of the policy variables were highest for the bond market, followed by the stock market and public sector government borrowing, which had up to 29% and 26% (respectively) of their variations explained by the combined policy variables. Other variables explored tended to have between 2% and 10% of their variations explained by the combined policy variables.

Individually, the evidence suggests that the ISSR and optimism shocks were the key drivers of variability in the currency market, with ISSR having more impact in the immediate term and optimism often having a larger impact in the longer term. A significant observation in the stock market is that as much as 70% to 80% of all policy shocks were accounted for by shocks to complexity of communication in the immediate period. We suggest that complexity

significantly impacts financial markets in the immediate term but as markets get more clarity over time, the effects of complexity wear out and the intentional policy rate takes more of an effect. For the bond markets, we found consistent evidence that optimism shocks accounted for the largest variations in the bond indices in the first few months but this fell over time and the ISSR became the dominant influence on variations by the 24th month, sometimes explaining up to 95% of policy variations as with the 10-year government bonds. Similarly, optimism shocks accounted for most of the variation in inflation variables with the exception of house price indices, which were instead affected by the ISSR (ISSR essentially being the policy rate). When we turned to real output variables the ISSR became the most significant policy variable explaining variations in unemployment, weekly earnings and public sector borrowing significantly more than any of the other policy variables.

Our key findings in this section of our work were that optimism shocks tended to have a significant impact on macroeconomic and financial market variables in a way that was similar to a contractionary policy. In addition to this, we found that relative to the policy rate, optimism shocks explained more of the variations in many macroeconomic and financial variables in the near term, particularly in the currency and bond markets as well as with inflation variables. There is some reasoning to these findings as these may suggest that optimism drives variables that respond more quickly to policy changes such as the currency and bond market variables as well as retail sales and consumer credit variables. Similarly, we also found that shocks to complexity of communication overwhelmingly explained the variations in the stock market in the immediate term when compared to policy rate (ISSR) shocks and optimism shocks.

Finally, the sixth chapter of our work addressed our fourth research question and sought to examine whether the complexity and optimism in the bank's communication had an impact on the volatility of financial market variables. Specifically, we explored the impact of these communication variables on the volatility of the stock markets, the currency markets and the bond markets. Our most significant finding in this section was that rising optimism in communication reduced volatility in the stock market and currency market. We found that a significant number of our stock market and currency market variables showed reduced volatility with increased optimism. Some of the evidence from the corporate sector does indeed corroborate the idea that optimism in CEO speeches tends to reduce volatility in the stock prices of the company (e.g. see Li et al. 2008). Our results seem to suggest that largely, complexity of communication has very limited effects on the volatility of the stock, currency and bond markets.

Overall, each of the three key analytical chapters provide interesting results that contribute to the literature and have significant implications for policy. The next section of our work details some policy implications of our work as well as areas for further research.

7.1 Implications for policy

The three main chapters of our research provide significant empirical findings that are potentially useful for central banks as well as for other policy making institutions. In our first analysis, we explored how communication via MPC minutes and inflation reports are influenced by the macroeconomic conditions in which the BoE is making that communication. Here, our findings provide very useful information for central banks in helping them understand what drives the clarity and tone with which they make policy communication. Although the manner in which central banks often communicates in response to the macroeconomic conditions may be unintentional on the part of the banks, the evidence suggests that their communications is significantly influenced by the macroeconomic conditions prevailing at the time of the communication. Therefore, our findings have significant policy implications for central banks in that they can consciously adjust the clarity and tone of communication ex-ante, in response to the existing macroeconomic conditions.

Particular emphasis can be placed on improving clarity by reducing the complexity of texts used in communication where there are economic environments with significantly rising inflation, widening inflation gaps and falling sterling values. In many cases, in such difficult conditions, the bank itself may be unclear as to how to communicate; however, by eliminating the tendency to communicate with increased complexity, and by using more clearly written language, communication will be more transparent. Being aware of the tendency for communication to be unclear in such periods as our evidence suggests will indeed help the bank improve its transparency practices.

In our second analysis, we explored whether communication shocks driven by clarity and optimism have the ability to impact the macroeconomic environment and in what direction. Given that an increasing number of central banks are turning to communication as an alternative policy tool to drive short-term expectations, and there is still no consensus on what dimensions of communication to measure and how these may quantitatively impact the macroeconomic environment as interest rates would, our results here are very interesting. In this study, we provide evidence that the clarity and tone of communication impacts key

macroeconomic variables and may thus be used to drive policy expectations. Specifically, optimism in policy communication seemed to drive macroeconomic and financial variables in a similar manner to how traditional policy rate would, while complexity shocks have the effects of calming inflation and output but also depressing stock and currency markets. The idea that optimism shocks impact the economy similar to a contractionary policy presents policy alternatives to central banks. Particularly, at the zero lower bound where further lowering interest rates may not be viable, optimism in communication (as well as complexity) may become a viable policy tool with which the central bank may drive policy.

Finally, our third analytical chapter explores the role that communication plays in transmitting volatility by exploring the effects of communication on the volatility of financial markets. Although we are unable to infer the effects of complexity of communication on volatility, we found consistent evidence that across most of the financial market variables that we explored, more optimistic communication tended to drive down market volatility. Given the foregoing, it can be argued that using more optimistic language may be a way for the central banks to dampen market volatility where possible.

7.3 Limitations

Although our research provides useful insights into the relatively new research area of central bank communication, it is important to highlight the limitations of our study. First, and in common with foregoing research into central bank communication, is the limitations of quantifying text as data. For our measures of tone, despite the advancement and extremely large corpus of the computerised textual analysis software used, it is still challenging to capture text within the right context. Although Diction allows for some assisted machine learning where some words are adapted to suit the context of the entire text, it is nonetheless still limited in its ability to recognise the context of word use; for instance,, the use of the words ‘doves’ and ‘hawks’ in central banking are examples of this. Indeed, Loughran and McDonald (2016) identify that a number of the words used by Diction for text classification are likely to be misclassified.

Furthermore, our measure of complexity, which used a combination of word length and sentence length to quantify the opacity of a text, may sometimes identify simple sentences that have long words as being complex. Some studies have found that the various readability

statistics produce different results when used to quantify clarity of the same text. Studies such as Mailloux et al. (1995) suggested that the way to overcome this limitation was to take an average of a number of readability statistics as this tends to provide a more reliable measure. Importantly, our study identified this limitation from the outset and employed up to six readability statistics for our initial analysis; however, we found these statistics to be very highly correlated and therefore reported only the Flesch-Kincaid scores.

Finally, there should be some caveat to interpreting communication coming from central banks as some of these communications may not be as deliberate as researchers make them out to be. Particularly where we evaluate minutes and inflation reports, some of the tone and clarity we observed may be significantly driven by the writing style of the publishing team rather than the deliberate actions of the bank's monetary policy committee. Overall, research into central bank communication requires some caution as not all communication documents may fully reflect the thinking of policy makers.

7.4 Future research

Our research into what drives the clarity and tone of MPC minutes and inflation reports released by the Bank of England, as well as the onward effects of these communications on the macro and financial environment, has produced some very interesting results. It is therefore important to extend this analysis within a wider framework to test the consistency of our findings across other communication channels such as speeches and interviews. It would be useful to explore if carefully crafted communication such as MPC minutes and inflation reports impact the macro economy in the same way as less crafted or off-the-cuff statements in interviews and speeches.

Additionally, given that a number of leading central banks have continued to turn to communication as an integral part of their policy tool, it will again be useful to explore if these results hold for other central banks as well. Although some work has been done on leading central banks, such as the Federal Reserve and the European Central Bank, there are aspects of our work that are unique and will provide useful insights for these other central banks. In particular, our analysis of sentiments using Diction is relatively new to the literature.

Finally, as leading economies move away from the zero lower bound environment and interest rates begin to rise, it is important that future research explore the role of communication and the role of interest rate changes comparatively within a non-zero lower bound environment.

Given that communication and forward guidance are now very integral to central banks' policy tool kits, partly due to the zero lower bound interest rates, it is important to re-evaluate the continued relevance of communication as a policy tool in the absence of the zero lower bound.

APPENDIX

Appendix A: Non-linear analysis of the relationship between complexity/tone and the macroeconomic environment.

As per our analysis of the linear relationship between the complexity and tone of the Bank of England's communication and existing macroeconomic conditions, we propose the model below similar to that of Bulir et al. (2013):

$$C_{it} = \alpha + \beta_{\pi}\pi_t + \beta_{\pi c}|\pi_t - \pi_t^*| + \beta_{\pi e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_{\gamma}\gamma_t + \beta_D DIR + \beta_{FC} FC + \beta_T T_{it} + \varepsilon_{it} \quad \dots (A1)$$

Where C_{it} denotes the relevant measure of complexity or tone of MPC minutes and inflation reports (i representing either of those). The Flesch-Kincaid Grade Level score is used to measure complexity of communication, with higher values implying communication that is more complex and one in which a reader will require more years of formal education to comprehend. Diction is used to obtain values for optimism and uncertainty tones, with higher values of the optimism score implying a more optimistic communication and a higher value of the certainty score implying less uncertainty.

π_t represents the current month-on-month growth rate of inflation and seeks to capture the inflationary pressures from inflation growth. The contemporaneous inflation gap is captured by the covariate $|\pi_t - \pi_t^*|$ and captures inflationary pressures from deviating further away from the inflation target in current period t and this is measured in absolute terms. $|E_t(\pi_{t+4}) - \pi_t^*|$ captures the forward-looking (ex-ante) inflation gap, which is the difference between the four-quarters-ahead inflation forecast and the inflation target γ_t is the value of the pound relative to the US dollar; DIR is a dummy variable that takes the value of 1 in a month when inflation reports are released in addition to MPC communication and 0 otherwise.

In the above model, we assume that there is a linear relationship between complexity and tone of communication and the macroeconomic conditions in which these communications are made. For robustness, however, we propose a number of non-linear scenarios and explore whether this would improve the fit of our model and provide us with more information.

A useful starting point is making assumptions as to the behaviour of an inflation-targeting central bank under an accountability framework. Specifically, given that the Bank of

England (via its governor) is required to write a letter to the chancellor when $|\pi_t - \pi_t^*| > 1$ ⁷, therefore as $|\pi_t - \pi_t^*|$ approaches 1, there is a tendency for the bank to be more concerned about breaching this threshold. As such, our expectations are that there is an increased incentive for communication to be increasingly impacted as the contemporaneous inflation gap approaches the threshold. Beyond this point, however, since the threshold is already reached, the incentive to alter communication may not be as much as the pre-threshold period. In fact, the bank may experience a disincentive to alter communication the further away $|\pi_t - \pi_t^*|$ moves beyond the threshold, as the bank may see altering communication further as an ineffective approach. We therefore expect the relationship between C_{it} and $|\pi_t - \pi_t^*|$ to be more of a concave rather than linear relationship. To this effect, we introduce the non-linear form of the contemporary inflation gap - $|\pi_t - \pi_t^*|^2$ into equation 8.1 above.⁸

Furthermore, we make assumptions as to the interactions between inflation pressures and exchange rate pressures. We propose that the magnitude of the impact of inflationary pressures on the bank's communication depends on the performance of sterling. Specifically, if the pound has depreciated, increasing inflationary pressures will tend to have a more significant impact on communication. Therefore, we argue that inflation impacts communication through its interaction with exchange. To model this relationship, we include an interaction variable $\pi_t\gamma_t$ that captures the interaction between inflation rate and exchange rate. Our non-linear model therefore takes the form below:

$$C_{it} = \alpha + \beta_\pi\pi_t + \beta_{\pi c}|\pi_t - \pi_t^*| + \beta_{\pi e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_\gamma\gamma_t + \beta_D DIR + \beta_{Fc} FC + \beta_t T_{it} + \beta_{\pi p}|\pi_t - \pi_t^*|^2 + \beta_{\pi\gamma}\pi_t\gamma_t + \varepsilon_{it} \quad \dots (A2)$$

Where $|\pi_t - \pi_t^*|^2$ is a polynomial of the contemporaneous inflation gap and $\pi_t\gamma_t$ captures the interaction of the inflation rate and the exchange rate variable. The results of equation 8.2 above are presented in table 8.1 below.

⁷ Note that the contemporaneous inflation gap is measured in absolute values. In reality this value will take a negative or positive form depending on which direction inflation is moving in.

⁸ This variable has a maximum value that is capped $|\pi_t^* \pm 3|$ which is the inflation target plus or minus 3%. We arbitrarily assume that $|\pi_t^* \pm 3|$ as the inflection point whereby the bank would have no incentive to significantly alter communication any further.

Table A1: Impacts of macroeconomic variables on complexity and tone of MPC Minutes (including non-linear variables)

	Model 1 (Complexity of communication)	Model 2: (Tone of communication)	Model 3: (Tone of communication)
	<i>Dependent Variable - Flesch-Kincaid Grade Level</i>	<i>Dependent Variable - Optimism</i>	<i>Dependent Variable - Certainty</i>
<i>Constant</i>	13.95*** (2.04)	43.79*** (2.59)	52.53*** (3.98)
<i>Current inflation rate (π_t)</i>	0.97 (0.79)	0.22** (0.10)	-0.16 (0.14)
<i>Contemporaneous inflation gap ($\pi_t - \pi_t^*$)</i>	-0.12 (0.27)	0.45 (0.40)	-0.73 (0.77)
<i>Forward-looking inflation gap ($E_t(\pi_{t+4}) - \pi_t^*$)</i>	12.57 (11.81)	50.81 (44.13)	50.56 (46.05)
<i>Exchange rate (γ_t)</i>	-1.01 (1.26)	4.40 (3.56)	-0.31 (2.31)
<i>Inflation report dummy (DIR)</i>	0.22** (0.10)	0.03 (0.13)	-0.28 (0.35)
<i>Financial crisis (FC)</i>	-0.48 (0.46)	-0.017 (0.30)	-1.08 (0.81)
<i>Time trend (T)</i>	0.0014 (0.0012)	0.00058 (0.0016)	-0.0025 (0.0030)
<i>Non-linear contemporaneous inflation gap ($\beta_{\pi\pi} \pi_t - \pi_t^* ^2$)</i>	0.28 (0.27)	-0.13 (0.15)	0.39 0.37
<i>Inflation-exchange interaction ($\pi_t\gamma_t$)</i>	0.0014 (0.094)	0.048 (0.043)	0.0029 (0.0041)
<i>SE of regression</i>	0.773176	1.197906	2.259200
<i>R squared</i>	0.210068	0.057511	0.047442
<i>Durbin Watson</i>	1.459928	1.441446	1.892173

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis

Our results show that with the exception of one (current inflation rate in model 2), none of the parameter estimates in the models returns a statistically significant value. When compared to our linear models, we find that the above models, although slightly more sophisticated, do not provide us with more information than our current model. Ramsey's RESET test carried out in the main body of the work also confirms that our linear model should perform better than our non-linear versions.

Appendix B: Subsample analysis of the MPC communication regimes

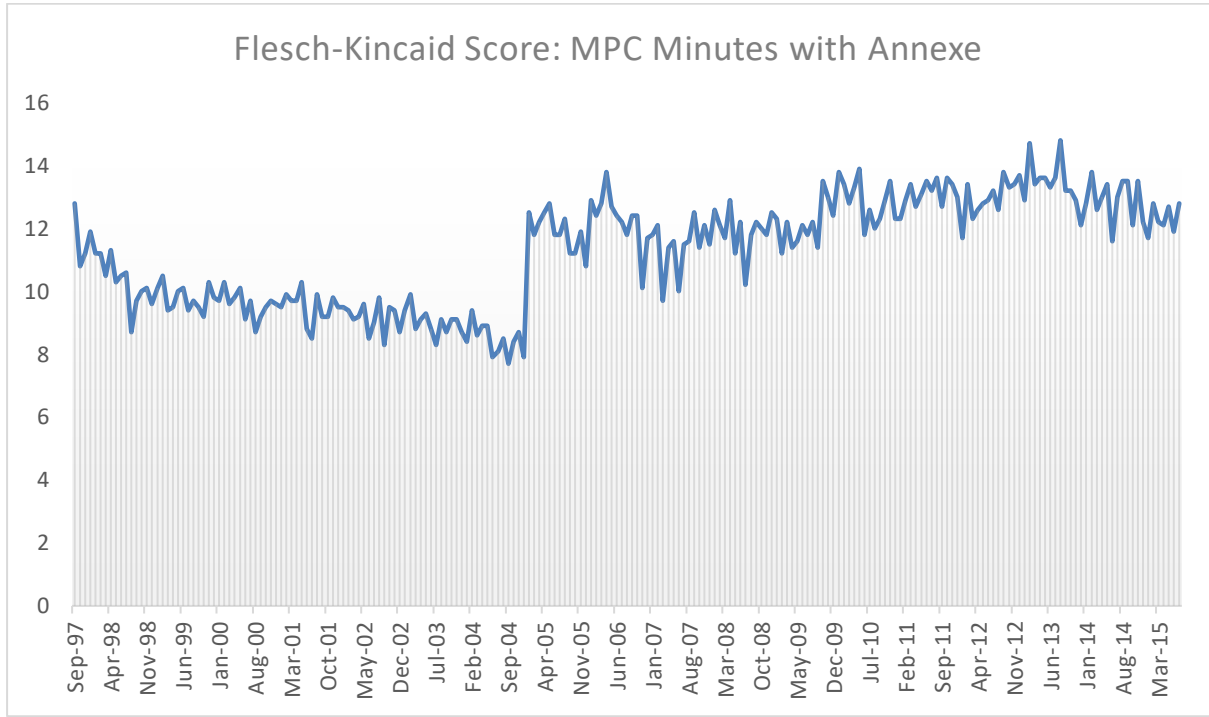
Subsample analysis: communication regime A (1997:09 – 2004:12)

Given that there was a change in the Bank of England's communication regime from January 2005 onwards, whereby the annexe section of the MPC was removed, we suggest that there might be a need to independently explore the sub-period from independence in 1997 to the withdrawal of the annexe in 2005. We should highlight that when we carried out a structural break analysis of the core MPC over our entire sample period using the January 2005 point as a break point, we found that our core MPC data did not exhibit a structural break in the time series. Nonetheless, we carried out a subsample analysis to see if these sub-periods added any additional information to our core analysis.

One of the key motivations for analysing the communication regime in the period between when the bank became independent in 1997 and the withdrawal of the annexe section in January 2005 is that the inclusion of the annexe section was argued to provide additional information used by the bank in deliberation at the MPC minutes. We therefore sought to explore two key issues as they relate to the inclusion of the annexe section in MPC minutes. First is whether this annexe section had any additional impact on clarity and tone of communication and second is whether our core research questions (i) and (ii), on the behaviour of the bank's communication in light of macroeconomic conditions, held for this sub-period as well. Recall that our research questions sought to address whether (i) there was a noticeable trend in the complexity and tone of MPC minutes and inflation reports given the increased demand for transparency and accountability and (ii) whether the prevailing macroeconomic conditions had an impact on the complexity and tone of the bank's communication.

As highlighted below in figure B1, the inclusion of the annexe section in our MPC minutes does depict that complexity of the text is reduced when this section is included. We should note, however, that this is somewhat expected given that most of the focus of the annexe is on presenting quantitative data which can be more succinct than deliberations. The time series data for the tone of optimism and uncertainty does not show any noticeable difference when we compare the pre-2005 communication regime and the longer time series; nonetheless we carried out pre-2005 analyses for these as well so as to check whether there were any noticeable differences in tone between the different communication regimes.

Figure B1: Complexity of MPC minutes with annexe (pre-2005)



Our model for analysing the sub-period is similar to that used in equation 4.1 in the main text, as is shown below:

$$C_{it} = \alpha + \beta_{\pi}\pi_t + \beta_{\pi c}|\pi_t - \pi_t^*| + \beta_{\pi e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_{\gamma}\gamma_t + \beta_D DIR + \beta_t T_{it} + \varepsilon_{it} \quad \dots (B1)$$

The variables used in the model in equation B1 above and what they represent are similar to those in equation 4.1 and are well described in chapter four of the main body of our work. However, our time series for this analysis is shorter and only covers the period between September 1997 and December 2004. Additionally, given that this period does not cover the global financial crises of 2008, we eliminated the financial crisis variable. The results of our regression analysis are displayed in table B1 below.

Table B1: Impacts of macroeconomic variables on complexity and tone of MPC Minutes (September 1997 to December 2004)

	Model 1 (Complexity of communication)	Model 2: (Tone of communication)	Model 3: (Tone of communication)
	<i>Dependent Variable - Flesch-Kincaid Grade Level</i>	<i>Dependent Variable - Optimism</i>	<i>Dependent Variable - Certainty</i>
<i>Constant</i>	9.71*** (0.78)	55.61*** (3.13)	56.15*** (2.47)
<i>Current inflation rate (π_t)</i>	1.89** (0.79)	-9.3*** (0.35)	-11.49*** (2.77)
<i>Contemporaneous inflation gap ($\pi_t - \pi_t^*$)</i>	0.22 (0.13)	-6.40*** (1.81)	-1.43 (0.57)
<i>Forward-looking inflation gap ($E_t(\pi_{t+4}) - \pi_t^*$)</i>	-5.57 (9.53)	(12.0)*** (3.2)	2.42 (39.22)
<i>Exchange rate (γ_t)</i>	0.061 (0.48)	-2.39 (1.86)	-0.69 (1.37)
<i>Inflation report dummy (DIR)</i>	0.33*** (0.12)	-0.12 (0.26)	-0.42 (0.48)
<i>Time trend (T)</i>	- 0.023*** (0.0028)	0.029*** (0.009)	-0.011 (0.010)
<i>SE of regression</i>	0.53	1.48	2.07
<i>R squared</i>	0.67	0.16	0.18
<i>Durbin Watson</i>	1.5	1.66	1.90

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis

When we compared our results from the pre-2005 communication regime, as shown in table B1 above, to those of the entire sample period, we found that the behaviour of complexity of communication over this period was largely similar to that of the entire sample period. Complexity of communication showed a downward trend over the period whilst rising inflation and the release of inflation reports in the same month were found to lead to more complex communication. The only difference in the results between the periods was that exchange rate did not significantly impact complexity of communication in the pre-2005 period. The reasons

for exchange rate not affecting communication in these periods are likely to be connected to the relative calm and stability of the pound relative to the dollar in the late 1990s and early 2000s.

Similarly, when we explored optimism in communication over the two periods, we found that optimism was impacted in a comparable manner. Rising inflation and widening contemporaneous inflation gap were found to reduce optimism while widening future inflation gaps seemed to increase optimism. The only difference across the time periods was that there was evidence that optimism rose over the pre-2005 time period, as the time trend variable in our equation is significant. Finally, we found that drivers in uncertainty in communication were explained better in the pre-2005 period as here we observed that rising inflation reduced certainty in communication. This is unlike the results of the entire sample period which showed that macroeconomic conditions, with the exception of a financial crisis, generally have no impact on the level of uncertainty in communication.

Overall, in this sub-sample period our results are largely consistent with those of the entire sample period. The only significant exceptions are exchange rate losing its significance in relation to its effects on complexity of communication and inflation driving uncertainty in communication. It may therefore be safe to conclude that the withdrawal of the annexe section from the minutes had no significant impact on the manner in which the Bank's communication were made.

Appendix C – Macroeconomic variable inputs to the FAVAR Model

	Transformation code	Slow/Fast Moving (1/0)
UK Industrial Production MoM SA	5	1
UK Industrial Production YoY SA	5	1
UK Manufacturing Production MoM SA	5	1
UK Manufacturing Production YoY SA	5	1
RICS England & Wales Housing Market Survey Price Balance SA	5	1
UK Trade Balance in Goods SA	5	1
UK Trade Balance Value of Trade Balance SA	5	1
UK Construction Output Total New Work Constant Prices SA MoM	5	1
Bank of England/TNS Inflation Expectation Survey Inflation Next 12 Mths	1	0
UK CPI EU Harmonized MoM NSA	5	1
UK CPI EU Harmonized YoY NSA	5	1
UK CPI Ex Energy Food Alcohol & Tobacco YoY	5	1
UK RPI All Items NSA	5	1
UK RPI MoM NSA	5	1
UK RPI YoY NSA	5	1
UK RPI Less Mortgage Interest Payments YoY NSA	5	1
UK PPI Input Prices Materials & Fuels Purchased Manufacturing MoM NSA	5	1
UK PPI Input Prices Materials & Fuels Purchased Manufacturing YoY NSA	5	1
UK PPI Manufactured Products MoM NSA	5	1
UK PPI Output Prices Ex Food Beverages Tobacco & Petroleum YoY NSA	5	1
UK House Price Index - Average Price for All Dwellings YoY	5	1
UK Claimant Count Rate SA	4	1
UK Unemployment Claimant Count Monthly Change SA	1	1
Average Weekly Earnings 3 Month Avg Growth Whole Economy YoY	5	1
UK AWE Regular Pay Whole Economy 3M Avg YoY SA	5	1
UK Unemployment ILO Unemployment Rate SA	4	1
UK Labour Force Employment Change	1	1
UK Retail Sales All Retailing Sales Ex Automotive Fuel Chained Volume MoM SA	5	1
UK Retail Sales All Retailing Sales Ex Automotive Fuel Chained Volume YoY SA	5	1
UK Retail Sales Volume Including Automotive Fuel MoM	5	1
UK Retail Sales Volume Including Automotive Fuel YoY	5	1

UK PSNCR Public Sector Net Cash Requirement	5	1
UK Cent Govt Net Cash Requirement ex.Northern Rock Asset Mgmt & Bradford&Bingley	5	1
UK PSNCR Net Borrowing	5	1
CBI MTE Full Volume of Total Order Book Balance	5	1
CBI MTE Full Average Selling Prices Next 3 Months Balance	5	1
UK Consumer Credit Supplied (Ex SLC) SA	5	1
UK Lending to Individuals Net Lending Secured On Dwellings in Billions	5	1
Bank of England UK Mortgage Approvals	5	1
UK Money Supply M4 MoM SA	5	1
UK Money Supply M4 YoY SA	5	1
GFK UK Consumer Confidence Indicator	4	1
UK IOS Index Total Service Industries MoM	5	1
UK IOS Index Total Service Industries 3 Mth/3 Mth	5	1
UK Business Investment Chained QoQ SA	5	1
UK Business Investment Chained YoY SA	5	1
UK Total Unit Labour Costs YoY	5	1
CBI ITS Q1 Quarterly Optimism Balance	4	0
GBP-USD	5	0
GBP-EUR	5	0
GBP-GPY	5	0
GBP - CHF	5	0
GBP-CAD	5	0
GBP -AUD	5	0
GBP-SEK	5	0
FTSE 100	5	0
FTSE 250	5	0
FTSE 350	5	0
FTSE ALL Share	5	0
UK Govt Bonds 10 Year Note Generic Bid Yield	1	0
UK Govt Bonds 1 Year Note Generic Bid Yield	1	0
UK Govt Bonds 5 Year Note Generic Bid Yield	1	0
UK Govt Bonds 3 Year Note Generic Bid Yield	1	0
GDP	5	1
UK New Car Registrations YoY	5	1
UK Official Reserves Changes in Net Reserves	5	1
BRC KPMG Retail Sales Monitor Like For Like Sales YoY	5	1
SGI Bond GBP 6M	5	0
SGI 2Y Bond GBP	5	0
SGI 5Y Bond GBP	5	0
SGI 10Y Bond GBP	5	0

Appendix D: Impact of lagged volatility variables on communication

This section supports our examination of possible reverse causation as explained in section 6.6 of our work. In the main body of the work, we tested the effects of the lagged volatility of currency and stock markets as measured by the squared residuals from the E-GARCH equations on our measures of communication. Our analysis used a model that regressed our two main measures of communication (i.e. complexity and optimism) on their own lags and the lagged volatility of currency and financial market variables measured as the squared residuals. We found that neither currency and financial market volatilities had any impact on any of the measures of communication.

This section takes that analysis further by inserting these lagged volatilities into our original model in equation 4.1 to test whether these had any impact on communication. Our revised model therefore takes the form below:⁹

$$C_{it} = \alpha + \beta_{\pi}\pi_t + \beta_{\pi_c}|\pi_t - \pi_t^*| + \beta_{\pi_e}|E_t(\pi_{t+4}) - \pi_t^*| + \beta_{\gamma}\gamma_t + \beta_D DIR + \beta_{FC} FC + \xi_{1t} + \xi_{2t} + \varepsilon_{it} \quad \dots (D.1)$$

Where the newly included variables ξ_{1t} and ξ_{2t} are the lagged volatility of the currency and bond market respectively, measured as the squared residuals from the E-GARCH equations in chapter 6. Table C1 below shows a summary of our results

Table D1 - Effects of lagged volatility on communication variables using original models.

	Model 1 (Complexity of communication)	Model 2: (Tone of communication)
	<i>Dependent Variable - Flesch-Kincaid Grade Level</i>	<i>Dependent Variable - Optimism</i>
<i>Constant</i>	15.96*** (0.79)	50.25*** (1.16)
<i>Current inflation rate (π_t)</i>	9.95* (5.99)	-19.17* (10.31)

⁹ Note that we excluded the time trend variable from this model as it did not present any additional information.

<i>Contemporaneous inflation gap</i> ($ \pi_t - \pi_t^*$)	-0.0064 (0.096)	-0.0059 (0.16)
<i>Forward-looking inflation gap</i> ($E_t(\pi_{t+4}) - \pi_t^*$)	-4.61 (2.58)	1.78 (3.78)
<i>Exchange rate</i> (γ_t)	-2.17*** (0.49)	0.58 (0.72)
<i>Inflation report dummy</i> (DIR)	0.24** (0.11)	0.0023 (0.14)
<i>Financial crisis</i> (FC)	-0.36 (0.26)	-0.46 (0.30)
<i>Lagged currency market volatility</i> (ξ_{it})	1.55 (1.65)	-0.32 (2.01)
<i>Lagged financial market volatility</i> (ξ_{it})	-0.00029 (0.00049)	1.55 (1.03)
<i>SE of regression</i>	0.77	1.21
<i>R squared</i>	0.22	0.041
<i>Durbin Watson</i>	1.50	1.43

*, **, *** denote significance at the 10%, 5% and 1% levels respectively.

HAC standard errors, bandwidth 4 (Bartlett kernel) in parenthesis

As with our previous analysis in the main body of the work, our results show that lagged currency and financial market volatilities had no impact on both the complexity and optimism of communication. These results support the previous findings in suggesting that there is no evidence of reverse causation in our models.

Appendix E: Summary of research questions, expected findings and thesis findings

Research question (i)	Hypothesis/Expected findings	Thesis findings
Given the increased demand for transparency and accountability, is there an observable trend in the complexity and tone of Bank of England's communication over our sample period?	<p>Null hypothesis:</p> <p>H_0: There is no statistically significant trend in the complexity and tone of the Bank of England's communication over our sample period.</p> <p>$H_0: T_{it} = 0$ $H_1: T_{it} \neq 0$</p> <p>Where T_{it} is the linear time trend variable in equation 4.1 of our work.</p> <p>Expected findings:</p> <p>The evidence in the literature suggests that inflation-targeting central banks have become increasingly transparent over the past decade. In the case of the Bank of England, there is also an increased demand for accountability from the oversight of the Treasury Select Committee. Our expectations are therefore for communication to reflect less complexity over our sample period.</p>	<p>We found evidence that the complexity of MPC minutes published by the bank did indeed decrease over our sample period. By suggesting that clarity is an important precondition to transparency and accountability, this finding is in line with recent conclusions in the literature that central banks are employing every means they can to increase transparency. We did not, however, find evidence of the same decrease in the complexity of inflation reports as our trend variable turns out insignificant.</p>

Research question (ii)	Hypothesis/Expected findings	Thesis findings
Are the varying levels of complexity and tone of communication associated with the prevailing macroeconomic conditions in which the communication is made?	<p>Null hypothesis: H_0: No association between complexity and tone and prevailing macroeconomic conditions.</p> <p>$H_0: \beta_{\pi} = \beta_{\pi c} = \beta_{\pi e} = \beta_{\gamma} = 0$ $H_1: H_0 \text{ is not true}$</p> <p>Where, π represents current inflation rate, πc represents the contemporaneous inflation gap, πe represents forward looking inflation gap and γ represents the pound/dollar exchange rate.</p> <p>Expected findings: Our expectations were that the complexity and tone of communication should be impacted by the prevailing macroeconomic conditions at the time of communication. Specifically, as an inflation-targeting central bank is required to explain significant deviations of its policy actions from its inflation target, our expectations are that the bank may be '<i>less clear, less certain and less optimistic</i>' when macroeconomic environments are unfavourable. We suggest that unfavourable conditions are those where</p>	<p>We found significant evidence that macroeconomic conditions have a sizeable impact on the complexity and tone of the Bank of England's communication.</p> <p>Our core finding is that rising inflation and falling pound values both tended to increase the complexity of MPC minutes and inflation reports. Generally, inflationary pressures seemed to be the dominant driver of complexity and tone across both MPC minutes and inflation reports. Rising inflation rate was observed to reduce optimism in MPC minutes and increase uncertainty in inflation reports. Furthermore, we found consistent evidence that as inflation deviated further from the inflation target both MPC minutes and inflation reports were significantly less optimistic.</p>

	prevailing inflation is rising and is further away from its target and exchange rate pressures are leading to the depreciation of the pound.	
Research question (iii)	Hypothesis/Expected findings	Thesis findings
Does central bank communication transmit shocks to key macroeconomic and market variables environment?	<p>Null hypothesis: H_0: There is no shock transmission from complexity and optimism of the bank's communication to key macroeconomic and market variables.</p> <p>Expected findings: Our expectations are for shocks from the complexity and optimism in communication to be transmitted to core financial and macroeconomic variables. Although there are suggestions in the literature (e.g. see Hansen and McMahon, 2016) that communication shocks barely impact real macroeconomic variables. we propose that rising optimism in central bank communication may be perceived by the public as leading to a contractionary policy and may impacts variables as such. Our expectations for the direction of complexity shocks are very much exploratory.</p>	<p>We found that overall, following shocks to optimism in the Bank of England's communication, inflation, output, and stock market returns fell and the pound rose in value. We found further evidence that optimism shocks reduced credit availability, the money supply, retail sales and as earnings. Finally, government bond yields also tended to rise in response to optimism shocks. These results seem to mimic responses to a traditional interest rate shock in a way that is consistent with contractionary economic policy. These findings are in line with our argument that with increased optimism in policy communication, individuals and firms expect a rise in interest rate and they respond by making economic decisions in line with this expectation.</p> <p>We observed that complexity shocks tended to reduce inflationary pressures</p>

		<p>and caused significant stock and currency market declines as well as a fall in bond yields. We found mixed evidence on the effects of complexity shocks on output and credit availability variables.</p> <p>In addition to this, we found that relative to the policy rate, optimism shocks explained more of the immediate variations in many macroeconomic and financial variables especially the currency markets, bond markets and inflation variables. Notably, shocks to complexity of communication overwhelmingly explained the variations in the stock market in the immediate term when compared to the policy rate and optimism shocks. Overall, however, the policy rate explained most of the variations in the majority of the variables over the longer term.</p>
--	--	---

Research question (iv)	Hypothesis/Expected findings	Thesis findings
Does central bank communication significantly impact volatility in financial markets?	<p>Null hypothesis: H_0: Complexity and optimism of the Bank of England's communication have no impact on the volatility of financial market variables.</p> <p>Expected findings: For complexity of communication, our expectations here are aligned with the strand of the literature which suggests that more complex communication calms financial markets (e.g. see Geraats 2007, Ehrmann and Fratzcher (2007c). This idea that ambiguity calms markets also has support within central banking practice, with leading central bankers such as Alan Greenspan suggesting that ambiguity is useful in calming financial markets with his suggestion that '<i>mumbling with great incoherence</i>' is an effective tool in central banking.</p> <p>For optimism, we follow some of the arguments in the corporate literature which suggest that CEO and company communications reduce stock market volatility by instilling confidence in markets</p>	<p>Our results seem to suggest that largely, complexity of communication has very limited effects on the volatility of the stock, currency and bond markets. We did, however, find that rising optimism in communication reduced volatility in the stock market and currency market. In line with our expectations, we found that a significant number of our stock market and currency market variables show reduced volatility with increased optimism.</p>

	(e.g. see Li et al. 2008). Our expectations therefore are for increased optimism to lead to reduced volatility in the financial markets.	
--	--	--

References

- Acosta, J.M., (2015). 'FOMC Responses to Calls for Transparency: Evidence from the Minutes and Transcripts Using Latent Semantic Analysis.' *Mimeograph, University of Stanford*.
- Allcott, H. and Gentzkow, M. (2017). 'Social Media and Fake News in the 2016 Election'. *Journal of Economic Perspectives* 31 (2), 211-236
- Amarasingam, A. (2011). 'The Stewart/Colbert Effect: Essays on the Real Impacts of Fake News.' *North Carolina: McFarland and Company*
- Andersson, M., and B. Hofmann, (2009). 'Twenty Years of Inflation Targeting: Lessons Learned and Future Prospects'. *Cambridge University Press*.
- Arslan-Ayaydin, Ö., Boudt, K., and Thewissen, J. (2015). 'Managers Set the Tone: Equity Incentives and the Tone of Earnings Press Releases'. *Journal of Banking & Finance*, 72, 132-147
- Ataullah, A., Vivian, A. and Xu, B., (2018). 'Time-varying Managerial Overconfidence and Corporate Debt Maturity Structure.' *The European Journal of Finance*, 24(2), pp.157-181.
- Bagliano, F. C. and Favero, C. A. (1998). 'Measuring Monetary Policy with VAR Models: An Evaluation'. *European Economic Review*, 42 (6), 1069-1112
- Bank of England (2014). *One Bank Research Agenda*: available from <http://www.bankofengland.co.uk/research/Documents/onebank/discussion.pdf>
- Baker, S.R., Bloom, N. and Davis, S.J.(2016). 'Measuring Economic Policy Uncertainty.' *The Quarterly Journal of Economics*, 131(4), pp.1593-1636.
- Barkemeyer, R., Comyns, B., Figge, F., and Napolitano, G. (2014). 'CEO Statements in Sustainability Reports: Substantive Information Or Background Noise?'. *Accounting Forum*, 38 (4), 241-257.
- Barnett, W. A., Bhadury, S. S., and Ghosh, T. (2016). 'An SVAR Approach to Evaluation of Monetary Policy in India: Solution to the Exchange Rate Puzzles in an Open Economy'. *Open Economies Review*, 27 (5), 871-893
- Barro, R. J. and Gordon, D. B. (1983). 'Rules, Discretion and Reputation in a Model of Monetary Policy'. *Journal of Monetary Economics*, 12 (1), 101-121
- Baumeister, C., Liu, P. and Mumtaz, H., (2010). 'Changes in the Transmission of Monetary Policy: Evidence from a Time-Varying Factor-Augmented VAR. *Bank of England. Quarterly Bulletin*, 50(4), p.346.
- Berger, H., Ehrmann, M., and Fratzscher, M. (2011). 'Monetary Policy in the Media'. *Journal of Money, Credit and Banking*, 43 (4), 689-709

- Bernanke, B. (1980). 'Irreversibility, Uncertainty, and Cyclical Investment'. *National Bureau of Economic Research Working Paper*, 502
- Bernanke, B.S. and Boivin, J., (2003). 'Monetary Policy in a Data-Rich Environment.' *Journal of Monetary Economics*, 50(3), pp.525-546.
- Bernanke, B. S., Boivin, J., and Elias, P. (2005). 'Measuring the Effects of Monetary Policy: A Factor-Augmented Vector Autoregressive (FAVAR) Approach'. *The Quarterly Journal of Economics*, 120 (1), 387-422
- Bernanke, B. S. and Reinhart, V. R. (2004). 'Conducting Monetary Policy at Very Low Short-Term Interest Rates'. *The American Economic Review*, 94 (2), 85-90
- Bernanke, B. S. (2001). 'Inflation Targeting: Lessons from the International Experience.' *Princeton University Press*
- Bernanke, B. S., Gertler, M., Watson, M., Sims, C. A., and Friedman, B. M. (1997). 'Systematic Monetary Policy and the Effects of Oil Price Shocks'. *Brookings Papers on Economic Activity*, 1997 (1), 91-157
- Bernanke, B.S., Laubach, T., Mishkin, F.S. and Posen, A.S., (1999). 'Missing the Mark-The Truth about Inflation Targeting.' *Foreign Affairs*, 78, p.158.
- Bernanke, B.S. and Mishkin, F.S., (1997). 'Inflation Targeting: A New Framework for Monetary Policy?'. *Journal of Economic Perspectives*, 11(2), pp.97-116.
- Bernanke, B.S. and Gertler, M., (1995). 'Inside the black box: the credit channel of monetary policy transmission'. *Journal of Economic Perspectives*, 9(4), pp.27-48.
- Bernanke, B. S. and Blinder, A. S. (1992). 'The Federal Funds Rate and the Channels of Monetary Transmission'. *The American Economic Review*, 901-921
- Bernoth, K. and Hagen, J. v. (2004). 'The Euribor Futures Market: Efficiency and the Impact of ECB Policy Announcements'. *International Finance*, 7 (1), 1-24
- Betts, J., Pickart, M. and Heistad, D., (2009). 'An Investigation of the Psychometric Evidence of CBM-R Passage Equivalence: Utility of Readability Statistics and Equating for Alternate Forms'. *Journal of School Psychology*, 47(1), pp.1-17.
- Bholat, D., Hansen, S., Santos, P., and Schonhardt-Bailey, C. (2015). 'Text Mining for Central Banks.' *Bank of England: Centre for Central Banking Studies*
- Biddle, G.C., Hilary, G. and Verdi, R.S., (2009). 'How Does Financial Reporting Quality Relate to Investment Efficiency?'. *Journal of Accounting and Economics*, 48(2-3), pp.112-131.
- Blinder, A.S., (2009). 'Monetary Policy by Committee: Why and how?'. *European Journal of Political Economy*, 23(1), pp.106-123.

- Blinder, A., Goodhart, C., Hildebrand, P., Lipton, D. and Wyplosz, C., (2001). 'How do central banks talk?', Geneva Reports on the World Economy 3, *Center for Economic Policy Research*.
- Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J., and Jansen, D. (2008). 'Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence'. *National Bureau of Economic Research Working Paper*, 13932
- Boero, G., Smith, J., and Wallis, K. F. (2008). 'Uncertainty and Disagreement in Economic Prediction: The Bank of England Survey of External Forecasters'. *The Economic Journal*, 118 (530), 1107-1127
- Bomberger, W. A. (1996). 'Disagreement as a Measure of Uncertainty'. *Journal of Money, Credit and Banking*, 381-392
- Born, B., Ehrmann, M., and Fratzscher, M. (2014). 'Central Bank Communication on Financial Stability'. *The Economic Journal*, 124 (577), 701-734
- Born, B., Ehrmann, M., and Fratzscher, M. (2012). 'Communicating about Macro-Prudential Supervision - A New Challenge for Central Banks Communicating about Macro-Prudential Supervision'. *International Finance*, 15 (2), 179-203
- Brewer, P. R., Young, D. G., and Morreale, M. (2013). 'The Impact of Real News about “fake News”: Intertextual Processes and Political Satire'. *International Journal of Public Opinion Research*, 25 (3), 323-343
- Buiter, W. H., Corsetti, G., and Pesenti, P. A. (2001). 'Financial Markets and European Monetary Cooperation: The Lessons of the 1992-93 Exchange Rate Mechanism Crisis'. *Cambridge University Press*
- Bulíř, A., Čihák, M. and Jansen, D.J., (2013). What Drives Clarity of Central Bank Communication about Inflation?. *Open Economies Review*, 24(1), pp.125-145.
- Bulir, A., Cihak, M. and Jansen, D.J., (2014). Does the Clarity of Inflation Reports Affect Volatility in Financial Markets?. *IMF Working Paper*, 14(175).
- Campbell, J. R., Fisher, J. D., Justiniano, A., and Melosi, L. (2017). 'Forward Guidance and Macroeconomic Outcomes since the Financial Crisis'. *NBER Macroeconomics Annual*, 31 (1), 283-357
- Campbell, J. R., Evans, C. L., Fisher, J. D., and Justiniano, A. (2012). 'Macroeconomic Effects of Federal Reserve Forward Guidance'. *Brookings Papers on Economic Activity*, 2012 (1), 1-80
- Campbell, J. Y. and Ammer, J. (1993). 'What Moves the Stock and Bond Markets? A Variance Decomposition for long-term Asset Returns'. *The Journal of Finance*, 48 (1), 3-37
- Cho, C. H., Roberts, R. W., and Patten, D. M. (2010). 'The Language of US Corporate Environmental Disclosure'. *Accounting, Organizations and Society*, 35 (4), 431-443.

- Chortareas, G., Stasavage, D. and Sterne, G., (2002). 'Does it pay to be Transparent? International Evidence from Central Bank Forecasts.' *Federal Reserve Bank of Saint Louis*, 84(4), pp.99-118.
- Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). 'Monetary Policy Shocks: What have we Learned and to what End?'. *Handbook of Macroeconomics*, 1, 65-148
- Clatworthy, M. and Jones, M.J., (2001). 'The Effect of Thematic Structure on the Variability of Annual Report Readability'. *Accounting, Auditing & Accountability Journal*, 14(3), pp.311-326.
- Clare, A., Courtenay, R., (2001). 'What Do We Learn About Monetary Policy From Financial Market Data?'. *Economic Research Centre of the Deutsche Bundesbank*, Discussion Paper 06/01
- Clarida, R., Gali, J., and Gertler, M. (2000). 'Monetary Policy Rules and Macroeconomic Stability: Evidence and some Theory'. *The Quarterly Journal of Economics*, 115 (1), 147-180
- Commons Treasury Select Committee (2011). 21st Report - Accountability of the Bank of England. *available from*
<https://publications.parliament.uk/pa/cm201012/cmselect/cmtreasy/874/87402.htm>
- Conover, C.M. and G.R. Jensen. and R. R. Johnson. (1999). 'Monetary Condition and International Investing'. *Financial Analysts Journal CFA Institute*, 55.4, 38-48.
- Cox, J., Ingersoll, J., and Ross, S. (1985). 'A Theory of the Term Structure of Interest Rates'. *Econometrica*, 53 (2), 385-407
- Craig, R. J. and Brennan, N. M. (2012). 'An Exploration of the Relationship between Language Choice in CEO Letters to Shareholders and Corporate Reputation'. *Accounting Forum*, 36 (3), 166-177.
- Crowe, C. and Meade, E. E. (2008). 'Central Bank Independence and Transparency: Evolution and Effectiveness'. *European Journal of Political Economy*, 24 (4), 763-777
- Cukierman, A. (2011). 'Reflections on the Crisis and on its Lessons for Regulatory Reform and for Central Bank Policies'. *Journal of Financial Stability*, 7 (1), 26-37
- Cukierman, A. and Meltzer, A. H. (1986) 'A Theory of Ambiguity, Credibility, and Inflation under Discretion and Asymmetric Information'. *Econometrica: Journal of the Econometric Society*, 1099-1128
- Courtis, J.K., (1998). 'Annual Report Readability Variability: Tests of the Obfuscation Hypothesis'. *Accounting, Auditing & Accountability Journal*, 11(4), pp.459-472.
- Davis, A. K. and Tama-Sweet, I. (2012). 'Managers' use of Language across Alternative Disclosure Outlets: Earnings Press Releases Versus MD&A'. *Contemporary Accounting Research*, 29 (3), 804-837

- De Franco, G., Hope, O.K., Vyas, D. and Zhou, Y., (2013). 'Analyst report readability'. *Contemporary Accounting Research*, 32(1), pp.76-104.
- De Goeij, P. and Marquering, W. (2006). 'Macroeconomic Announcements and Asymmetric Volatility in Bond Returns'. *Journal of Banking & Finance*, 30 (10), 2659-2680
- Del Negro, M., Eusepi, S., Giannoni, M.P., Sbordone, A.M., Tambalotti, A., Cocci, M., Hasegawa, R. and Linder, M., (2013). 'The FRBNY DSGE model'. *FRB of New York Staff Report*, (647).
- Demertzis, M. and Hallett, A. H. (2007) 'Central Bank Transparency in Theory and Practice'. *Journal of Macroeconomics*, 29 (4), 760-789
- Dincer, N.N. and Eichengreen, B., (2007). 'Central Bank Transparency: Where, Why, and With What Effects?' *National Bureau of Economic Research*, (No. w13003).
- Eichengreen, B. and Dincer, N.N., (2014). 'Central Bank Transparency and Independence: Updates and New Measures'. *International Journal of Central Banking*, 10(1), pp.189-259.
- DuBay, W. H. (2004). 'The Principles of Readability': available from <<http://impact-information.com/impactinfo/readability02.pdf>>
- Duffy, T.M. and Kabance, P., (1982). 'Testing a Readable Writing Approach to Text Revision'. *Journal of Educational Psychology*, 74(5), p.733.
- Eijffinger, S.C. and Geraats, P.M., (2006). 'How Transparent are Central Banks?'. *European Journal of Political Economy*, 22(1), pp.1-21.
- Eijffinger, S. and Tesfaselassie, M.F., (2007). 'Central Bank Forecasts and Disclosure Policy: Why it pays to be Optimistic'. *European Journal of Political Economy*, 23(1), pp.30-50.
- Ehrmann, M. and Fratzscher, M. (2009a) 'Purdah—On the Rationale for Central Bank Silence around Policy Meetings'. *Journal of Money, Credit and Banking*, 41 (2-3), 517-528
- Ehrmann, M. and Fratzscher, M., (2009b). Explaining Monetary Policy in Press Conferences. *International Journal of Central Banking*, 5(2), pp.42-84.
- Ehrmann, M. and Fratzscher, M. (2009c). 'Global Financial Transmission of Monetary Policy Shocks'. *Oxford Bulletin of Economics and Statistics*, 71 (6), 739-759
- Ehrmann, M. and Fratzscher, M. (2007). 'Communication by Central Bank Committee Members: Different Strategies, Same Effectiveness?'. *Journal of Money, Credit and Banking*, 39 (2-3), 509-541
- Erceg, C. and Levin, A. (2006). 'Optimal Monetary Policy with Durable Consumption Goods'. *Journal of Monetary Economics*, 53 (7), 1341-1359
- Eusepi, S. and Preston, B. (2010). 'Central Bank Communication and Expectations Stabilization'. *American Economic Journal: Macroeconomics*, 2 (3), 235-271

- Evans, K. and Speight, A. (2010). 'International Macroeconomic Announcements and Intraday Euro Exchange Rate Volatility'. *Journal of the Japanese and International Economies*, 24 (4), 552-568
- Faust, J. and Svensson, L. E. (2001). 'Transparency and Credibility: Monetary Policy with Unobservable Goals'. *International Economic Review*, 42 (2), 369-397
- Ferrero, G. and Secchi, A. (eds.) (2007). 'The Announcement of Future Policy Intentions', 3rd Banca d'Italia-CEPR Conference on Money, Banking and Finance Monetary Policy Design and Communication, held 27/09/2007 at Rome. *Centre for Economic Policy Research*
- Ferris, S. P., Hao, Q., and Liao, M. (2012). 'The Effect of Issuer Conservatism on IPO Pricing and Performance'. *Review of Finance*, 17 (3), 993-1027
- Fišer, R. and Horvath, R. (2010). 'Central Bank Communication and Exchange Rate Volatility: A GARCH Analysis'. *Macroeconomics and Finance in Emerging Market Economies*, 3 (1), 25-31
- Fracasso, A., Genberg, H. and Wyplosz, C., (2003). 'How do central banks write?: An evaluation of inflation reports by inflation targeting central banks' (Vol. 2). *Centre for Economic Policy Research*.
- Fratzscher, M. (2006). 'On the Long-Term Effectiveness of Exchange Rate Communication and Interventions'. *Journal of International Money and Finance*, 25 (1), 146-167
- Freda, M.C., (2005). 'The readability of American Academy of Pediatrics Patient Education Brochures'. *Journal of Pediatric Health Care*, 19(3), pp.151-156.
- Friedman, M. (1968). 'The Role of Monetary Policy'. *American Economic Review*, 58 (1), 1
- Fry, M., Julius, D., Mahadeva, L., Roger, S. and Sterne, G., (2000). 'Key Issues in the Choice of Monetary Policy Framework'. *Monetary Policy Frameworks in a Global Context*, 1, pp.1-216.
- Gaballo, G., (2013). 'Rational Inattention to News: The Perils of Forward Guidance'. *American Economic Journal: Macroeconomics*, 8(1), pp.42-97.
- Gaspar, V., Smets, F., and Vestin, D. (2006). 'Adaptive Learning, Persistence, and Optimal Monetary Policy'. *Journal of the European Economic Association*, 4 (2-3), 376-385
- Gentzkow, M., Shapiro, J. M., and Stone, D. F. (2014). 'Media Bias in the Marketplace: Theory'. *NBER Working Paper*, No. 19880
- Geraats, P.M., (2002). 'Central Bank Transparency'. *The Economic Journal*, 112(483), pp.F532-F565
- Gerlach-Kristen, P., (2004). 'Is the MPC's Voting Record Informative about Future UK Monetary Policy?'. *Scandinavian Journal of Economics*, 106(2), pp.299-313.

- Geraats, P. M. (2007). 'The Mystique of Central Bank Speak'. *International Journal of Central Banking*, 3 (1), 37-80
- Giordani, P. and Söderlind, P. (2002). 'Inflation Forecast Uncertainty'. *European Economic Review*, 47 (6), 1037-1059
- Glick, R. and Leduc, S. (2012). 'Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets'. *Journal of International Money and Finance*, 31 (8), 2078-2101
- Gnabo, J., Laurent, S., and Lecourt, C. (2009). 'Does Transparency in Central Bank Intervention Policy Bring Noise to the FX Market?: The Case of the Bank of Japan'. *Journal of International Financial Markets, Institutions and Money*, 19 (1), 94-111
- Gorter, J., Jacobs, J., and De Haan, J. (2008). 'Taylor Rules for the ECB using Expectations Data'. *The Scandinavian Journal of Economics*, 110 (3), 473-488
- Goyal, A. and Arora, S. (2012). 'The Indian Exchange Rate and Central Bank Action: An EGARCH Analysis'. *Journal of Asian Economics*, 23 (1), 60-72
- Graddy, D. B. & Beauchamp, C. F. (2014). 'The Greenspan effect: A retrospective analysis of Alan Greenspan's speeches'. *International Journal of Humanities and Social Science*, 4 (11), 1-14.
- Grüner, H. P. (2002). 'How Much should Central Banks Talk?'. *Economics Letters*, 77 (2), 195-198.
- Gürkaynak, R. S., Sack, B., and Swanson, E. T. (2005). 'Do Actions Speak Louder than Words? The Response of Asset Prices to Monetary Policy Actions and Statements'. *International Journal of Central Banking*, 2 (1), 18-42
- Hansen, S. and McMahon, M. (2016). 'Shocking Language: Understanding the Macroeconomic Effects of Central Bank Communication'. *Journal of International Economics*, 99, S114-S133
- Hansen, S., McMahon, M. and Prat, A., (2017). 'Transparency and Deliberation within the FOMC: a Computational Linguistics Approach'. *The Quarterly Journal of Economics*, 133(2), pp.801-870.
- Harford, J. & R. J. Schonlau. (2013). 'Does the Director Labor Market Offer ex-post Settling-up for CEOs? The Case of Acquisitions'. *Journal of Financial Economics*, 110(1): 18-36.
- Hargis, G., Carey, M., Hernandez, A.K., Hughes, P., Longo, D., Rouiller, S. and Wilde, E., (1998). 'Developing Quality Technical Information: A Handbook for Writers and Editors'. *Pearson Education*.
- Hayo, B., Kutun, A.M. and Neuenkirch, M., (2009). 'FOMC Communication and Emerging Equity Markets'. *EMG Joint Discussion Paper Series in Economics*, (No. 2009, 23).

- Hayo, B. and Neuenkirch, M. (2015). 'Self-Monitoring or Reliance on Media Reporting: How do Financial Market Participants Process Central Bank News?'. *Journal of Banking & Finance*, 59, 27-37
- Hayo, B. and Neuenkirch, M. (2012). 'Bank of Canada Communication, Media Coverage, and Financial Market Reactions'. *Economics Letters*, 115 (3), 369-372
- Hayo, B., Kutan, A., and Neuenkirch, M. (2008), 'Communicating with Many Tongues: FOMC Speeches and U.S. Financial Market Reaction'. *MAGKS Joint Discussion Paper Series in Economics* 08–2008.
- Heinemann, F. and Ullrich, K. (2005). 'Does it Pay to Watch Central Bankers' Lips? The Information Content of ECB Wording'. *ZEW Discussion Papers*, No. 05-70
- Hendry, S. (2012). 'Central Bank Communication or the Media's Interpretation: What Moves Markets?'. *Bank of Canada Working Paper*, 2012-9
- Henzel, S., Hülsewig, O., Mayer, E., and Wollmershäuser, T. (2009). 'The Price Puzzle Revisited: Can the Cost Channel Explain a Rise in Inflation After a Monetary Policy Shock?'. *Journal of Macroeconomics*, 31 (2), 268-289
- Hilary, G., Hsu, C., Segal, B., and Wang, R. (2016). 'The Bright Side of Managerial Over-Optimism'. *Journal of Accounting and Economics*, 62 (1), 46-64.
- Horvath, R. and Vaško, D. (2016). 'Central Bank Transparency and Financial Stability'. *Journal of Financial Stability*, 22, 45-56
- Issing, O. (2014). 'Communication and Transparency – the Example of the ECB'. *Journal of Economic Dynamics and Control*, 49, 70-73
- Ivrendi, M. and Guloglu, B. (2010). 'Monetary Shocks, Exchange Rates and Trade Balances: Evidence from Inflation Targeting Countries'. *Economic Modelling*, 27 (5), 1144-1155
- Jansen, D. and Moessner, R. (2016). 'Communicating Dissent on Monetary Policy: Evidence from Central Bank Minutes'. *Netherlands Central Bank, Research Department*
- Jansen, D. (2011a). 'Mumbling with Great Incoherence: Was it really so Difficult to Understand Alan Greenspan?'. *Economics Letters*, 113 (1), 70-72
- Jansen, D. (2011b). 'Does the Clarity of Central Bank Communication Affect Volatility in Financial Markets? Evidence from Humphrey-Hawkins Testimonies'. *Contemporary Economic Policy*, 29 (4), 494-509
- Jurado, K., Ludvigson, S.C. and Ng, S., (2015). 'Measuring uncertainty'. *American Economic Review*, 105(3), pp.1177-1216.
- Kahneman, D. (2003). 'Maps of Bounded Rationality: Psychology for Behavioral Economics'. *The American Economic Review*, 93 (5), 1449-1475
- Kearney, C. and Liu, S. (2014). 'Textual Sentiment in Finance: A Survey of Methods and Models'. *International Review of Financial Analysis*, 33, 171-185

- Kim, S., (2003). 'Monetary Policy, Foreign Exchange Intervention, and the Exchange Rate in a Unifying Framework'. *Journal of International Economics*, 60(2), pp.355-386.
- Kim, S. and Roubini, N. (2000). 'Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach'. *Journal of Monetary Economics*, 45 (3), 561-586
- King, M., Barnes, S., Bean, C., Campbell, J., Cassino, E., Evans, P., Farrant, K., Felices, G., Hatch, N., and Kansagra, R. (2002). 'The Inflation Target Ten Years on'. *Bank of England Quarterly Bulletin*, Winter 2002.
- King, M. (1997). 'Changes in UK Monetary Policy: Rules and Discretion in Practice'. *Journal of Monetary Economics*, 39 (1), 81-97
- Klare, G. R. (1976). 'A Second Look at the Validity of Readability Formulas'. *Journal of Reading Behavior*, 8 (2), 129-152
- Kohn, D.L. and Sack, B.P., (2003). 'Central Bank Talk: Does it Matter and Why?'. *Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board*.
- Kool, C., Thornton, D., (2012). 'How Effective is Central Bank Forward Guidance?'. *Federal Reserve Bank of St. Louis Working Paper*, No. 2012-063A.
- Koop, G. and Korobilis, D. (2010). 'Bayesian Multivariate Time Series Methods for Empirical Macroeconomics'. *Foundations and Trends in Econometrics*, 3 (4), 267-358
- Korobilis, D. (2012). 'Assessing the Transmission of Monetary Policy using Time-varying Parameter Dynamic Factor Models'. *Oxford Bulletin of Economics and Statistics*, 75 (2), 157-179
- Krippner, L., (2015). 'Zero Lower Bound Term Structure Modeling': A practitioner's guide'. *Springer*.
- Lahiri, K. and Sheng, X. (2010). 'Measuring Forecast Uncertainty by Disagreement: The Missing Link'. *Journal of Applied Econometrics*, 25 (4), 514-538
- Leiderman, L. and Svensson, L. E. (1995). 'Inflation Targets'. *Centre for Economic Policy Research London*
- Levin, A. T., Natalucci, F. M., and Piger, J. M. (2004). 'The Macroeconomic Effects of Inflation Targeting'. *Federal Reserve Bank of Saint Louis*, 86 (4), 51-58
- Levin, A., López-Salido, D., Nelson, E., and Yun, T. (2010). 'Limitations on the Effectiveness of Forward Guidance at the Zero Lower Bound'. *International Journal of Central Banking*, 6 (1), 143-189
- Li, F. (2010). 'The Information Content of forward-looking Statements in Corporate filings—A Naïve Bayesian Machine Learning Approach'. *Journal of Accounting Research*, 48 (5), 1049-1102

- Li, F. (2010). 'Textual Analysis of Corporate Disclosures: A Survey of the Literature'. *Journal of Accounting Literature*, 29, 143
- Li, F. (2008). 'Annual Report Readability, Current Earnings, and Earnings Persistence'. *Journal of Accounting and Economics*, 45 (2–3), 221-247
- Loughran, T. and McDonald, B. (2016). 'Textual Analysis in Accounting and Finance: A Survey'. *Journal of Accounting Research*, 54 (4), 1187-1230
- Loughran, T. and McDonald, B. (2014). 'Measuring Readability in Financial Disclosures'. *The Journal of Finance*, 69 (4), 1643-1671
- Loughran, T. and McDonald, B. (2011). 'When is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks'. *The Journal of Finance*, 66 (1), 35-65
- Lucca, D. O. and Trebbi, F. (2009). 'Measuring Central Bank Communication: An Automated Approach with Application to FOMC Statements'. *National Bureau of Economic Research Working Paper*, 15367
- Magill, M. and Quinzii, M. (2014). 'Term Structure and Forward Guidance as Instruments of Monetary Policy'. *Economic Theory*, 56 (1), 1-32
- Mailloux, S. L., Johnson, M. E., Fisher, D. G., and Pettibone, T. J. (1995). 'How Reliable is Computerized Assessment of Readability?'. *Computers in Nursing*, 13, 221-221
- Mankiw, N.G., Miron, J.A. and Weil, D.N., (1987). 'The Adjustment of Expectations to a Change in Regime: A Study of the Founding of the Federal Reserve'. *The American Economic Review*, pp.358-374.
- Mayew, W. J. and Venkatachalam, M. (2012). 'The Power of Voice: Managerial Affective States and Future Firm Performance'. *The Journal of Finance*, 67 (1), 1-43
- McCallum, B. T. (2000). 'The Present and Future of Monetary Policy Rules'. *International Finance*, 3 (2), 273-286
- McCallum, B. T. and Nelson, E. (1999). 'Performance of Operational Policy Rules in an Estimated Semiclassical Structural Model'. *Monetary Policy Rules*, University of Chicago Press, 15-56
- McKay, A., Nakamura, E., and Steinsson, J. (2016). 'The Power of Forward Guidance Revisited'. *The American Economic Review*, 106 (10), 3133-3158
- Meade, E. E. and Stasavage, D. (2008). 'Publicity of Debate and the Incentive to Dissent: Evidence from the US Federal Reserve'. *The Economic Journal*, 118 (528), 695-717
- Mishkin, F. S. (2004). 'Can Central Bank Transparency Go Too Far?'. *National Bureau of Economic Research Working Paper*, 10829
- Moessner, R., (2013). 'Reactions of Real Yields and Inflation Expectations to Forward Guidance in the United States'. *Applied Economics*, 47(26), pp.2671-2682.

- Morris, S. and Shin, H. S. (2002). 'Social Value of Public Information'. *American Economic Review*, 92 (5), 1521-1534
- Müller, U. K. (2014). 'HAC Corrections for Strongly Autocorrelated Time Series'. *Journal of Business & Economic Statistics*, 32 (3), 311-322
- Mumtaz, H. and Surico, P. (2007). 'The Transmission of International Shocks: A factor-augmented VAR Approach'. *Journal of Money, Credit and Banking*, 41 (s1), 71-100
- Musard-Gies, M. (2006). 'Do European Central Bank's Statements Steer Interest Rates in the Euro Zone?'. *The Manchester School*, 74 (s1), 116-139
- Nelson, D. B. (1991). 'Conditional Heteroskedasticity in Asset Returns: A New Approach'. *Econometrica*, 59, 347-70.
- Nickerson, R. S. (1998). 'Confirmation Bias: A Ubiquitous Phenomenon in Many Guises.' *Review of General Psychology*, 2 (2), 175
- Orphanides, A. and Williams, J. C. (2005). 'Inflation Scares and Forecast-Based Monetary Policy'. *Review of Economic Dynamics*, 8 (2), 498-527
- Orphanides, A. (2001). 'Monetary Policy Rules Based on Real-Time Data'. *American Economic Review*, 964-985
- Papadamou, S., Sidiropoulos, M., and Spyromitros, E. (2014) 'Does Central Bank Transparency Affect Stock Market Volatility?'. *Journal of International Financial Markets, Institutions and Money*, 31, 362-377
- Patelli, L. and Pedrini, M. (2014). 'Is the Optimism in CEO's Letters to Shareholders Sincere? Impression Management Versus Communicative Action during the Economic Crisis'. *Journal of Business Ethics*, 124 (1), 19-34
- Piazzesi, M. (2005). 'Bond Yields and the Federal Reserve'. *Journal of Political Economy*, 113 (2), 311-344
- Prat, A., (2005). 'The Wrong Kind of Transparency'. *American Economic Review*, 95(3), pp.862-877.
- Price, S. M., Doran, J. S., Peterson, D. R., and Bliss, B. A. (2012). 'Earnings Conference Calls and Stock Returns: The Incremental Informativeness of Textual Tone'. *Journal of Banking & Finance*, 36 (4), 992-1011
- Rabin, M. and Schrag, J. L. (1999). 'First Impressions Matter: A Model of Confirmatory Bias'. *The Quarterly Journal of Economics*, 114 (1), 37-82
- Ranaldo, A. and Rossi, E. (2010). 'The Reaction of Asset Markets to Swiss National Bank Communication'. *Journal of International Money and Finance*, 29 (3), 486-503
- Ranyard, R., Del Missier, F., Bonini, N., Duxbury, D., and Summers, B. (2008). 'Perceptions and Expectations of Price Changes and Inflation: A Review and Conceptual Framework'. *Journal of Economic Psychology*, 29 (4), 378-400

- Rhee, H. J. and Turdaliev, N. (2013). 'Central Bank Transparency: Does it Matter?'. *International Review of Economics & Finance*, 27, 183-197
- Rigobon, R. and Sack, B. (2004). 'The Impact of Monetary Policy on Asset Prices'. *Journal of Monetary Economics*, 51 (8), 1553-1575
- Rodrik, D. (1991). 'Policy Uncertainty and Private Investment in Developing Countries.' *Journal of Development Economics*, 36 - 229-242.
- Romer, C. D. and Romer, D. H. (2000) 'Federal Reserve Information and the Behavior of Interest Rates'. *American Economic Review* 90 (3), 429-457
- Romzek, B.S. and Dubnick, M.J., (1987). 'Accountability in the Public Sector: Lessons from the Challenger Tragedy'. *Public Administration Review*, pp.227-238.
- Rosa, C. and Verga, G. (2007). 'On the Consistency and Effectiveness of Central Bank Communication: Evidence from the ECB'. *European Journal of Political Economy*, 23 (1), 146-175
- Rosa, C. (2011). 'Words that Shake Traders: The Stock Market's Reaction to Central Bank Communication in Real Time'. *Journal of Empirical Finance*, 18 (5), 915-934.
- Rose, J. (1991). 'Political Uncertainty and Macroeconomic Performance'. *Economics Letters*, 37 (4), 377-381
- Rudebusch, G. D. (1995). 'Federal Reserve Interest Rate Targeting, Rational Expectations, and the Term Structure'. *Journal of Monetary Economics*, 35 (2), 245-274
- Schmeling, M. and Wagner, C. (2016). 'Does Central Bank Tone Move Asset Prices?'. *City, University of London Institutional Repository*
- Schonhardt-Bailey, C., (2013). 'Deliberating American Monetary Policy: A Textual Analysis'. *MIT Press*.
- Shiller, R. J. (2017). 'Narrative Economics'. *The American Economic Review*, 107 (4), 967-1004
- Shiller, R. J., Campbell, J. Y., Schoenholtz, K. L., and Weiss, L. (1983). 'Forward Rates and Future Policy: Interpreting the Term Structure of Interest Rates'. *Brookings Papers on Economic Activity*, 1983 (1), 173-223
- Sibert, A., (2006). 'Is Central Bank Transparency Desirable?'. *CEPR Discussion Papers*, (No. 5641)
- Sicilia, B. and Cruikshank, J. (2000). 'The Greenspan Effect.' *McGraw-Hill*, First edn. New York
- Sims, C. A. (1992). 'Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy'. *European Economic Review*, 36 (5), 975-1000

- Sims, C. A. (2003). 'Implications of Rational Inattention'. *Journal of Monetary Economics*, 50 (3), 665-690
- Stock, J. H. and Watson, M. W. (2002). 'Forecasting using Principal Components from a Large Number of Predictors'. *Journal of the American Statistical Association*, 97 (460), 1167-1179
- Sturm, J. and De Haan, J. (2011). 'Does Central Bank Communication Really Lead to Better Forecasts of Policy Decisions? New Evidence Based on a Taylor Rule Model for the ECB'. *Review of World Economics*, 147 (1), 41-58
- Svensson, L.E., (2014). 'Forward guidance'. *National Bureau of Economic Research*, (No. w20796)
- Svensson, L. E. (2006). 'Social Value of Public Information: Morris and Shin (2002) is Actually Pro Transparency, Not Con'. *American Economic Review* 96, 448-452
- Svensson, L. E. (2003). 'What is Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules'. *Journal of Economic Literature*, 41 (2), 426-477
- Svensson, L. E. (1997). 'Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets'. *European Economic Review*, 41 (6), 1111-1146
- Taylor, J. B. (1999). 'A Historical Analysis of Monetary Policy Rules'. *Monetary Policy Rules*, University of Chicago Press, 319-348
- Thorbecke, W. (1997). 'On Stock Market Returns and Monetary Policy'. *The Journal of Finance*, 52 (2), 635-654
- Tirole, J. (2002). 'Rational Irrationality: Some Economics of Self-Management'. *European Economic Review*, 46 (4), 633-655
- Van der Cruijssen, C. and Demertzis, M. (2007). 'The Impact of Central Bank Transparency on Inflation Expectations'. *European Journal of Political Economy*, 23 (1), 51-66
- Van der Cruijssen, Carin AB, Eijffinger, S. C., and Hoogduin, L. H. (2010). 'Optimal Central Bank Transparency'. *Journal of International Money and Finance*, 29 (8), 1482-1507
- van der Cruijssen, C. A. B. and Eijffinger, S. C. W. (2010). 'From Actual to Perceived Transparency: The Case of the European Central Bank'. *Journal of Economic Psychology*, 31 (3), 388-399
- Walsh, C. E. (2007). 'Optimal Economic Transparency'. *International Journal of Central Banking*, 3 (1)
- Wang, F. A. (2001). 'Overconfidence, Investor Sentiment, and Evolution'. *Journal of Financial Intermediation*, 10 (2), 138-170
- Warsh, K. (2014). *Transparency and the Bank of England's Monetary Policy Committee*. London: Bank of England

- Wei, Y., Lu, Y., Chen, J., and Hsu, Y. (2017). 'Informativeness of the Market News Sentiment in the Taiwan Stock Market'. *The North American Journal of Economics and Finance*, 39, 158-181
- Winkler, B., (2000). 'Which Kind of Transparency? On the need for clarity in monetary policy-making'. *European Central Bank*, (No. 0026).
- Wisniewski, T. P. and Yekini, L. S. (2015). 'Stock Market Returns and the Content of Annual Report Narratives'. *Accounting Forum*, 39 (4), 281-294.
- Woodford, M. (2011). 'Interest and Prices: Foundations of a Theory of Monetary Policy'. *New Jersey: Princeton University*, 3rd edn.
- Woodford, M. (2005). 'Central Bank Communication and Policy Effectiveness'. *National Bureau of Economic Research Working Paper*, 11898
- Woodford, M. (2001). 'The Taylor Rule and Optimal Monetary Policy'. *The American Economic Review*, 91 (2), 232-237
- Wooldridge, J. (2013). 'Introductory Econometrics: A Modern Approach.' *Cengage Learning*, 5th ed.
- Wu, J. C. and Xia, F. D. (2016). 'Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound'. *Journal of Money, Credit and Banking*, 48 (2-3), 253-291
- Yekini, L. S., Wisniewski, T. P., and Millo, Y. (2016). 'Market Reaction to the Positiveness of Annual Report Narratives'. *The British Accounting Review*, 48 (4), 415-430